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The Maine Agricultural Experiment Station

ORONO

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Report of Progress for Year Ending June 30, 1940

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THE MAINE AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE

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	Reiner Bonde, Ph.D., Associate
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CONTENTS

	PAGE
INTRODUCTION	185
APPLES	185
Apple Breeding	185
Thinning of Golden Delicious Apples	185
Winter Injury to Apple Trees	185
Insects Affecting the Apple Crop	188
The gypsy moth as an apple pest	188
The apple fruit fly (*Rhagoletis pomonella* Walsh)	189
Spreaders for insecticide sprays	191
Apple Scab Control	191
Twenty-six-year-old McIntosh trees	191
Young McIntosh trees, twelfth year	192
Apple Orchard Soil Fertility Experiment, Highmoor Farm	194
CANNING AND GARDEN CROPS	195
Sweet Corn	195
Sweet corn breeding	195
Sweet corn spacing trials	195
A comparison of ten seed lots of Golden Cross Bantam	196
Fertilizer experiments with sweet corn	206
Beans	202
Planting rate for snap beans	202
Effect of frequency of harvest on the yield and grade of snap beans	202
Effect of the application of nitrate of soda on the yield and grade of snap beans	203
Bean breeding	203
The Mexican bean beetle	203
Tomatoes	206
Date of planting	206
Tomato breeding	207
Cucumbers	207
Breeding cucumbers resistant to scab (*Cladosporium cucumerinum*)	207
Insecticides for the control of the striped cucumber beetle, *Diabrotica vittata*	207
Spinach	208
Seed treatment	208

Vegetable Variety Trials 208
Squash 209
Experiments with insecticides for the control of the squash bug, *Anasa tristis* De Geer 209
Pea Aphid Investigations 209
Cutworms and Army Worms Affecting Field and Garden Crops 211
CHEMISTRY 213
Work of Investigation 213
Chemical analyses in connection with the problems of nutrition and growth of poultry and dairy cattle 213
Soil analyses investigation and analysis of materials used in connection with the permanent rotation and fertility experiments at Aroostook Farm 213
Spray residues on apples 213
Strength of mercuric chloride solutions used in the treatment of seed potatoes 214
The conservation of ammonia in manure 215
DAIRYING 217
An Economic Study of the Dairy Industry in Maine 217
Dairy farm organization and management studies 217
Milk marketing in Maine 218
Milk marketing in New England 218
FAMILY ECONOMICS 219
How Maine Families Finance Higher Education 219
Household Equipment 221
The effect of the method of heat application, and accompanying oven conditions, upon flavor and texture of baked foods 221
A study of the performance of wood ranges heated by distillate burners and an evaluation of factors which affect their performance 224
FARM CREDIT 227
Farm Credit in Maine 227
FIELD CROPS 227
Field Corn Variety Trials 227
Small Grain Variety Test 229
Oats 229
Wheat 229
Barley 229

FOODS AND NUTRITION 229
A Study of the Food Habits and Nutritional Status of Children in Selected Communities in Maine 229
The Relation of the Dietary Habits and Food Resources of Maine People to Their State of Nutrition with Respect to Vitamin C 230
a. The availability for human nutrition of the vitamin C in potatoes 230
b. The effect of sodium chloride and vinegars on the oxidation of ascorbic acid (Vitamin C) 231
The Relation of Man and of Animals to the Environment. V. 235
a. Extra-nutritional determiners of malnutrition 235
b. The need for vitamin A foods and food crops and the genetic selection for varietal differences in carotene content 239
c. Requirements for the production of aggridant foods 245
FORAGE CROPS 248
Alfalfa Strain Trials 248
Grassland Studies 249
INSPECTION SERVICE 249
Testing of dairy glassware 250
Fertilizer inspection 250
Agricultural seeds. Fungicides and insecticides inspection 250
Food and drug inspection 250
Bacteriological work 251
Feeding stuffs inspection 251
Gasoline inspection 251
Motor lubricants inspection 251
LAND UTILIZATION 251
Land Use Studies in Maine 251
Soil Survey 252
Maine Soil Testing Service 252
POTATOES 252
Green Mountain Seed Plots 252
An Economic Study of the Potato Industry in Maine 253
Farm organization and costs and returns in producing potatoes in the St. John River area of Aroostook County, Maine, 1937 253

Farm organization and costs and returns in producing potatoes in central Maine, 1938 253
Marketing Maine Potatoes 254
Potato Fertilization 255
Fertilizer experiments with potatoes on permanent plots 255
Fertilizer experiments with potatoes on privately owned farms throughout Aroostook County 255
Spraying Potatoes for the Control of Early Blight 256
Studies on the Control of the Potato Ring Rot Disease (Bacterial Wilt and Soft Rot) 259
Control by disinfection of cut seed 260
Control by resistant varieties 261
Seed Disinfection of Potatoes 261
Purple Top Disease of the Potato 261
Effect on Potato Yield of Different Percentages of Virus Diseases 262
Cooking Quality of Potatoes 263
Florida Test Plot 264
Insecticides in Relation to the Control of Potato Virus Diseases 265
A Comparison of Shell Horticultural Spray and Black Leaf 40 in the Control of Aphids on Potatoes 268
Insects in Relation to the Transmission of Virus Diseases of Potatoes 271
Roguing Service for Producers of Foundation Seed Potatoes 272
SMALL FRUIT CROPS 274
Strawberry Breeding 274
Blueberry Investigations 275
Breeding and selection 275
Burning 275
Chemical study of the blueberry fruit 275
Weed control 275
Transplanting 276
High-bush blueberry culture 276
Blueberry Insects 276
Blueberry fruit fly (*Rhagoletis pomonella* Walsh) 276
Blueberry thrips (*Frankliniella vaccinii* Morgan) 277
ANNOUNCEMENTS 277

PUBLICATIONS 279
Bulletins Issued in 1939-1940..... 279
Official Inspections Issued in 1939-1940..... 279
Miscellaneous Publications Issued in 1939-1940..... 279
Abstracts of Papers Published by the Station in 1939-1940 but Not Included in the Bulletins..... 280
1937 and 1938 Additions and Corrections to the List of Causes of Fungus and Bacterial Plant Diseases in Maine..... 280
The Synonymy of *Fomes Fomentarius*..... 280
Potato Tuber Net-Necrosis and Stem-End Browning Studies in Maine..... 281
Comparative Studies of the Bacteria Associated with Potato Blackleg and Seed-Piece Decay..... 281
The Role of Insects in the Dissemination of Potato Blackleg and Seed-Piece Decay..... 282
Milk Production and Distribution Costs, and Prices for Milk in Maine..... 284
Pruning of the Low-Bush Blueberry..... 285
The Effect of Growth Substances on the Rooting of Blueberry Cuttings 285
Corrodentia as Pests of Ground Feed..... 286
Insect Pest Control in Young Orchards..... 286
Ten Years of Warfare Against the Blueberry Maggot.. 286
METEOROLOGICAL OBSERVATIONS..... 287
REPORT ON THE FINANCES OF THE STATION.. 292

INTRODUCTION

The progress of the research work of the Station is briefly summarized in this report for the fiscal year ending June 30, 1940. Pertinent financial and weather data are included. Efforts are being made constantly to adapt the research program to the changing conditions as they affect the agriculture of the State. It should be realized that, with the limited funds available, attention cannot be given to all of the problems confronting us. We can, however, make reasonable changes in the emphasis given to the various research studies with a view to keeping in step with the times.

APPLES

Apple Breeding. Russell M. Bailey and Iva M. Burgess. This work is receiving more attention than in years past due to the need for hardy winter apple varieties suited to Maine. A seedling apple orchard has been established with seedlings from controlled crosses involving promising parents. Around 1,500 trees are now in this orchard and the oldest of these are rapidly coming into bearing. Genetic data concerning characteristics of the F_1 crosses are being accumulated.

Thinning of Golden Delicious Apples. Russell M. Bailey and Frederick B. Chandler. Several sprays and hand thinnings were tried on the Golden Delicious trees at Highmoor Farm. The sprays caused some foliage damage and appeared to remove too many of the apples. Data are insufficient for definite conclusions.

Winter Injury to Apple Trees. Merle T. Hilborn. The work on winter injury to apple trees, begun following the severe winter of 1933-34, has shown that many varieties of commercial importance in Maine orchards need to be grown on a hardier kind of trunk. Four experimental hardy stock orchards were established in various parts of Maine in the spring of 1940. At Cornish, in cooperation with Mr. M. O. Lord, an orchard of 320

trees was planted. This orchard consists of 80 McIntosh, 80 Baldwin, and 80 trees each of two hardy stocks, Virginia Crab and Hibernal. Two similar orchards were set out respectively at Patten, in cooperation with the Woodman Potato Company, and at Highmoor Farm. A fourth orchard was established at Monmouth, in cooperation with Mr. S. L. Painter. Here 320 trees were planted consisting of 80 Spy, 80 Cortland, and 80 trees each of the hardy stocks, Virginia Crab and Hibernal.

The stock-scion relationships, with respect to hardiness, will be studied in these orchards. It is well established, both in Maine and elsewhere, that Virginia Crab and Hibernal are superior to fruiting varieties both in hardiness and in other trunk characteristics. It is not known, however, what effect a nonhardy variety, such as Baldwin, will have on a hardy stock, or *vice versa*. The hardiness of the Baldwin scion may be increased, the hardiness of the stock may be decreased, or there may be no effect at all. McIntosh, a variety susceptible to trunk injury, should be benefited considerably when top-worked on a hardy stock. Also, varieties, such as Spy and Delicious, that form narrow crotch angles on their own trunks and are susceptible to winter injury in these crotches, should be superior when top-worked on a hardy stock because these stocks normally form wide crotches.

Although it is fairly well established that Virginia Crab and Hibernal are well adapted to Maine conditions and are very hardy, much remains to be learned about their suitability as interstocks for all varieties now being grown in Maine orchards. Other hardy stocks are being added to experimental plantations as rapidly as they become available. In cooperation with Dr. J. H. Waring, of the Department of Horticulture, University of Maine, a nursery was established at Orono for the propagation of certain hardy varieties. Approximately 800 trees, Virginia Crab, Hibernal, Antonovka, and Charlamoff, were distributed from this nursery this spring to interested orchardists. In cooperation with Mr. F. C. Bradford, of the Division of Plant Exploration and Introduction, U. S. Department of Agriculture, many other hardy varieties from all parts of the world are being brought into this nursery. Some of these, particularly those from Poland and Russia, show promise of being more vigorous and more hardy than any varieties tested previously in this country.

The hardiness of Virginia Crab as compared with common nursery stock of fruiting varieties has been demonstrated in the orchard which was set out at Patten in 1938. This orchard consisted of 450 Virginia Crab, 300 McIntosh, 100 Cortland, 50 Spy, and smaller numbers of Baldwin, Yellow Transparent, Red Gravenstein, Wealthy, and Early McIntosh. The trees were planted in such a way that each fruiting variety was adjacent to a Virginia Crab top-worked to the same variety. Late fall rains and early low temperatures in October and November of 1939 resulted in considerable winter injury to most kinds of trees in this orchard. The injury to these young trees was strikingly similar to that found in older, fruiting trees of the same variety in 1933-34. McIntosh showed severe bark splitting on the trunks, Cortland showed bark discoloration and twig dieback, Spy and Red Gravenstein showed considerable twig dieback, and Baldwin was completely killed. This injury was independent of location within the orchard, occurring on the better soils as frequently as on the poorer ones. The percentage of trees injured in each of the varieties represented in this orchard is shown in Table 1.

TABLE 1

Percentage of Young Apple Trees Winter-Injured in the Woodman Potato Company Orchard at Patten

Variety	Percentage injured
Baldwin	100.0
Early McIntosh	100.0
Yellow Transparent	100.0
Spy	97.8
Cortland	87.1
Red Gravenstein	80.0
McIntosh	78.2
Wealthy	25.0
Virginia Crab	2.9

The injury, in most cases, will not be fatal to the trees, but the growth and yield apparently will be much less than that of the same variety top-worked on Virginia Crab. On the basis of these data and other observations both in Maine and elsewhere, it appears that Virginia Crab can be recommended for trial in orchards

where winter injury has been severe in the past. Caution should be exercised, however, as not enough is known as yet concerning the compatibility of this hardy stock with all varieties.

INSECTS AFFECTING THE APPLE CROP. Frank H. Lathrop. During the year 1939-40 studies were continued on insect pests in Maine apple orchards. The main features of the work are reviewed here.

The Gypsy Moth as an Apple Pest. The gypsy moth (*Porthetria dispar* L.) continued widespread destruction in woodlands of the infested areas in Maine during the summer of 1939. Apple trees that were not adequately protected by timely spray applications suffered severe injury. In general, the fruit and foliage of commercial orchards were well protected where lead arsenate was thoroughly applied in the pink, the calyx, and the first cover sprays.

Studies of the biology of the young gypsy larvae are beginning to produce interesting information. Daily observations were made on the hatching of the eggs in 100 egg masses at Highmoor Farm. The records of hatching are summarized graphically in Figure 1.

The drifting of the young larvae was studied in two orchards at Monmouth. In each orchard, 12 traps were distributed so as to be fairly representative of the orchard as a whole. Each trap consisted of a 3-foot square of 12-mesh wire screen painted with sticky tanglefoot, tacked on a wooden frame, and mounted on a post approximately 10 feet high. Each trap was placed so that the sticky screen faced east and west. As the gypsy caterpillars were carried into the orchard by the wind, those that drifted against the traps became entangled in the sticky tanglefoot and could not escape. Each day, the trapped larvae were counted and removed from the screens. Thus a record was made of the time and volume of drifting of the gypsy larvae into the orchards under observation. The results of the study are shown in Figure 1.

Spray tests, applied for the destruction of the young larvae, show that what appeared to be a repellent effect of the spray coating on the foliage may be of considerable importance in protecting apple trees from injury by the gypsy moth. In many cases, larvae confined on leaves sprayed with lead arsenate refused to feed normally and failed to grow, but lived on until apparently overcome by starvation.

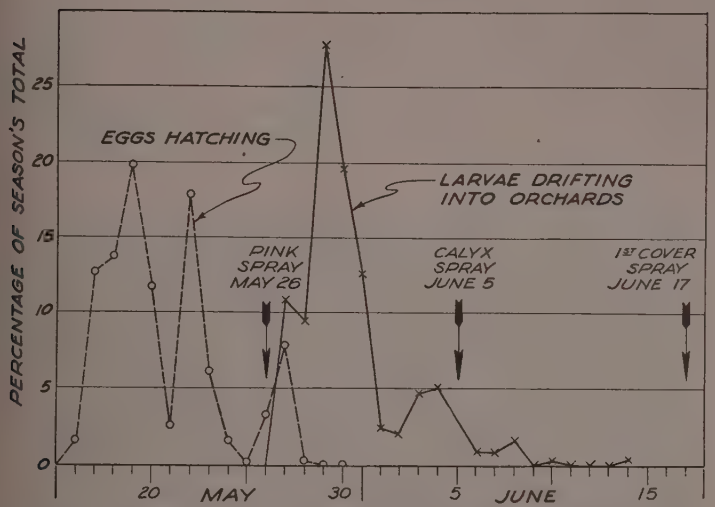

FIG. 1. Activity of the gypsy moth during the spring of 1940. The broken line shows the rate of hatching of gypsy eggs at Highmoor Farm. Note that the first eggs hatched on May 16. Hatching was completed on May 30—soon after the time of the pink spray. The greatest number of eggs hatched on May 19. The solid line shows the rate at which young gypsy larvae drifted into apple orchards in Monmouth. The first incoming larvae were noticed on May 27—the day after the pink spray. The last drifting larvae were captured on June 14—about the time the first cover spray was being applied in orchards in Monmouth. The greatest number ot drifting larvae were captured on May 29. The records show that 95.6 per cent of the drifting larvae entered the orchards before the time of the calyx spray.

The Apple Fruit Fly (*Rhagoletis pomonella* Walsh). The season of 1939 was characterized by a late and long-continued period of fly emergence. The first flies appeared in the observation cages at Highmoor Farm on July 3, which was eleven days later than in 1938. The flies appeared in large numbers daily from July 10 until August 6, after which the number of emerging flies decreased. The unusually late production of large numbers of flies increased the difficulty of protecting apples from infestation. Especially in orchards where the second fruit fly spray was omitted, there was in general an increased percentage of apples stung late in the season.

Spray tests showed that the addition of three gallons of skim milk per 100 gallons of the recommended fruit fly spray,[1] helped to reduce the formation of objectionable blotches of visible spray residue on the fruit (Figure 2). Apparently the skim milk spreader did not reduce the efficacy of the spray for fruit fly control.

FIG. 2. *Left*—Unsightly blotches of residue from the application of the spray recommended for fruit fly control.
Right—The deposit was smoothed out on these apples by adding 3 gallons of skim milk per 100 gallons of spray.

Preliminary tests were conducted with dichlorethyl ether as a soil insecticide for combating the apple fruit fly. A solution was prepared of 10 ml. of dichlorethyl ether per gallon of water, with the addition of 4 ml. of Aerosol OT 25 per cent clear. Applied to the soil at the rate of one gallon per square yard of surface, the solution failed to kill fruit fly pupae buried two inches beneath the surface. Further tests will be conducted.

[1] Calcium arsenate 2 pounds, hydrated lime 6 pounds, water 100 gallons. A sulphur fungicide is usually added.

Spreaders for Insecticide Sprays. J. Thomas Pedlow. For the purpose of increasing the efficiency of the spraying process, a study of spreaders and wetting agents for incorporation into insecticide sprays was started during the past year. It seemed essential for such a study that more or less quantitative data, on the ease of wetting by water of the common insecticides, be available. This information is now being accumulated. This phase of the study will be followed by investigating the wettability of insecticides by water containing representative wetting agents and spreaders.

APPLE SCAB CONTROL. Donald Folsom. Apple scab control was studied in two orchards on Highmoor Farm, with special attention being given to the growth rate of the trunk and the yield rate of fruits as affected by spray and dust materials, by soil, and by the type of stock used for grafting the nursery trees.

Twenty-six-year-old McIntosh Trees. In 1939, two rows of 26-year-old McIntosh trees, 20 to a row, had been compared for four successive years when receiving two different strengths of lime-sulphur spray respectively. Both rows were sprayed in 1939 with the same materials, with the same equipment, and on the same dates. The materials were Sulcaloid at the prepink and Mike thereafter. About 1,200 leaves and 3,400 apples were examined, and other measurements made, with the following general results:

Row	North	South
Strength previous 4 years	Full*	Half
Leaves scabby	11.0%	9.7%
Leaves burned	3.5%	1.5%
Fruits scabby	8.9%	9.7%
Fruits cull-scabby	1.0%	0.4%
Fruits russeted	0.5%	0.5%
Fruits clean	90.6%	89.8%
Average trunk girth in spring	67.5 cm.	67.6 cm.
Average girth increase	2.5 cm.	2.5 cm.
Fruit yield per tree	9.7 bus.	10.4 bus.

* By full strength is meant 1 gallon of liquid lime sulphur or 4 pounds of dry lime sulphur to 50 gallons of mixture.

None of the differences shown above were significant. The yield rates for the two rows have been as follows:

Row	North	South
Rate 1923-34 total per tree	25.4 bus.	21.0 bus.
Rate 1935-38 total per tree	27.0 bus.	26.9 bus.
Rate 1939 per tree	9.7 bus.	10.4 bus.
Relative for 1923-34	100.0	82.6
Relative for 1935-38	100.0	99.6
Relative for 1939	100.0	107.5

These results can be interpreted in two ways. Probably the south row yielded relatively better in 1935-38 than in previous years because it had "caught up" with the north row in internal conditions that favor fruitfulness, or because the four seasons in 1935-38 somehow favored the south row. On the other hand, it is possible that the reduction in concentration of the lime-sulphur mixture not only favored the south row in the four seasons characterized by it, but had a beneficial "hang-over" effect in 1939.

Young McIntosh Trees, Twelfth Year. In 1939, 336 McIntosh trees that were set out in the spring of 1928 were continued in several series. Each series received the same spray or dust treatment for the twelfth consecutive season, except for one series having been changed from a lead-arsenate treatment to a lime-sulphur treatment in 1936. About 97 per cent of the trees produced blossoms, about 94 per cent produced fruits, and the average yield rate of fruits for all trees was about 64 pounds per tree.

On August 8, about 1,800 leaves were examined in each series of trees, 100 leaves to a tree. At harvest time about 8,000 fruits were examined. Results are given in Table 2. The lime-sulphur trees received seven applications averaging about 2.4 gallons a tree, the sulphur-spray trees received seven applications averaging about 2.5 gallons a tree, and the sulphur-dust trees received seven applications averaging about 1.25 pounds a tree.

The effects, on the tree, of the same kinds of spray and dust treatment applied during consecutive years are shown in Table 3. The trunk girth is about the same for all treatments, but the two lime-sulphur series yielded much less per tree than the sulphur spray and dust series. The greatest difference noted in trunk girth was not significant, although the current year's increase in trunk girth for the sulphur-dust series, which has the greatest yield rate of total fruit to date, was significantly smaller than for

some other series. The sulphur-spray, sulphur-dust, and lead-arsenate series were significantly superior to the two lime-sulphur series in blossom abundance, yield rate for the current year, and yield rate of all years to date totalled. Summing up briefly, the sulphur-dust treatment seems to have permitted the greatest yield but at the expense of some wood formation, while the lime-sulphur treatment has not reduced wood formation but has reduced blossoming and fruiting.

TABLE 2

Current-Season Effects of Spray and Dust Materials on Apples, 1939

Treatment	Per cent leaves scabby	Per cent leaves burned	Per cent fruits scabby	Per cent fruits russeted	Per cent fruits clean
Dry lime-sulphur spray	0.4	5.8	0.1	2.2	97.7
Ditto; only lead arsenate to 1935 inclusive	0.7	6.0	0.1	1.4	98.6
"Micronized" sulphur spray	1.9	1.2	0.3	1.0	98.6
Bentonite sulphur dust	1.7	1.1	2.1	0.8	97.1
Only lead arsenate for tent caterpillar and gypsy moth	17.8	4.1	45.2	2.6	52.8

TABLE 3

Cumulative Effects of Spray and Dust Materials on Apple Trees, for the Twelve Years Ending 1939

Treatment	Trees 1939		Trunk girth 1939			Blossoms 1939*	Fruits 1939		Fruits 1933 to 1939 inclusive	
	Total	Per cent fruiting	Increase (cm.)	Final (cm.)	Ratio of final		Pounds per tree	Ratio of yield rate	Pounds per tree	Ratio of yield rate
Lime sulphur	67	96	4.01	39.5	102.1	2.5	49	60.5	96	49.7
Ditto; only lead arsenate to 1935 inclusive	65	85	3.94	39.8	102.8	2.2	40	49.4	107	55.4
Sulphur spray	65	97	3.98	40.7	105.2	3.3	81	100.0	185	95.9
Bentonite sulphur dust	65	95	3.62	38.7	100.0	3.4	71	87.7	193	100.0
Only lead arsenate for tent caterpillar and gypsy moth	74	96	3.73	38.9	100.5	3.7	78	96.3	156	80.8

* Abundance of blossoms estimated May 26 in 6 grades from 0 (none) to 5 (most).

APPLE ORCHARD SOIL FERTILITY EXPERIMENT, HIGHMOOR FARM. Merle T. Hilborn and Delmar S. Fink. The Highmoor Farm apple orchard experiments have been enlarged to include a soil fertility experiment on the McIntosh variety. The fundamental object of the experiment is to study the influence of differential fertilizer treatments on winter hardiness. In addition, information will be obtained on the interacting effect of fertilizer treatment and winter inury on tree growth, yield, and foliage condition in McIntosh.

This orchard was established on land that had been uncultivated long enough to permit the growth of pine that varied from eight inches to two feet in diameter. The treatments were started immediately following planting, and the effects of these treatments will be observed throughout the life of the orchard. This procedure, from a strictly soil viewpoint, will give much valuable information on the effects of these treatments on soil fertility improvement.

The following treatments were applied on duplicate plots of six trees each:

0—no treatment.
1—nitrogen close to trees in usual manner.
2—nitrogen close to trees and lime over entire plot.
3—nitrogen and phosphorus close to trees and lime over entire plot.
4—nitrogen, phosphorus and potash close to trees and lime over entire plot.
5—nitrogen, phosphorus and potash close to trees.
6—nitrogen, phosphorus, potash and lime over entire plot.
7—nitrogen, phosphorus, potash and lime over entire plot plus mulch close to trees.
8—manure and lime over entire plot.

High magnesium limestone will be applied at the rate of one ton per acre until a desirable soil reaction is attained. Nitrogen, phosphorus, and potash will be applied respectively at the rate of 100 pounds N, 100 pounds P_2O_5, and 100 pounds K_2O per acre. Nitrogen will be applied annually throughout the life of the trees and phosphorus and potash until a very desirable soil level of these elements is reached.

CANNING AND GARDEN CROPS

Sweet Corn. *Sweet Corn Breeding.* Russell M. Bailey. Considerable attention is devoted to sweet corn breeding because of the importance of this canning crop to Maine. In 1939 more attention was placed on the development of breeding stock. A graduate fellowship established in 1936 by the Maine Canners' Association has aided in the research program and has enabled the Experiment Station to provide technical assistance to Maine packers in the production of hybridized seed.

Approximately 30 hybrids appeared promising in the trials at Highmoor Farm in 1939. These were planted again in 1940 on a more extensive scale in three locations in the State in order to provide a more thorough test of their commercial possibilities.

The hybridized sweet corn seed produced in Maine at present by the canning industry comprises two groups of top crosses.

(1) Line 100 crosses. These have been in comparison with Maine strains of open pollinated Golden Bantam each year since 1932 at Highmoor. The increase in yield of this group of top crosses over the Golden Bantam has ranged from 7 per cent to 33 per cent with practically the same maturity season. The plant type and uniformity are not equal to the later hybrids. This group cannot be recommended for use outside Maine because of susceptibility to wilt disease and low vegetative vigor.

(2) Purdue 1339 crosses. Baxcross P39 and Maine Tricross are produced by the Maine Canners at present. These hybrids are several days to a week later maturing than group 1 but yield better and are more vigorous. Due to the later maturity they are not recommended for frosty locations.

Two commercial hybrids which can be recommended for use in Maine are Top Cross Maine Bantam and Tendergold. Both mature later than the Line 100 crosses. Golden Cross is of too late maturity for general recommendation in Maine.

Sweet Corn Spacing Trials. Russell M. Bailey. This study was undertaken in 1937 in cooperation with the Maine Canners' Association. The data, obtained in 1939 with respect to the effect of different plant distances on yield, ear length and size, barren plants, and maturity and per cent of usable ears, substantiate the findings reported in Maine Agricultural Experiment Station Bulletin 397, pages 706-708, 1939.

As a general statement it appears that the most desirable spacing distance for a given variety is influenced by soil conditions. Under very fertile conditions with plenty of moisture, close planting has given the greatest return, but on infertile soils or those subject to drought, more feeding area per plant should be provided to obtain the maximum use of available moisture and nutrients. Early varieties with less vegetative vigor require less feeding area than the later maturing more vegetative ones. Approximately two square feet of feeding area per plant for early canning varieties and around two and one-half square feet for the late varieties or hybrids appear to be optimum for most conditions.

A Comparison of Ten Seed Lots of Golden Cross Bantam. Russell M. Bailey. Wide differences in maturity season of Golden Cross Bantam obtained from different sources have been reported. Ten lots of Golden Cross Bantam seed were planted in a Latin square for study in 1939 with the following results:

1. All lots of Golden Cross Bantam were nearly the same for time of maturity. One or two days was the maximum difference between the earliest and latest lots. The difference was on the borderline of significance. Statistical analysis of the data indicated that soil variation was a greater factor in causing maturity difference than source of the seed.

2. No significant difference in yield of the various lots could be demonstrated.

3. A significant difference between lots in the number of rows of kernels per ear was found. The Golden Cross Bantam with the lowest count averaged 11.7 rows per ear and the highest 12.4.

4. There was a marked difference between the percentages of green tassels in various lots. Some produced entirely green tassels and others entirely red; most produced some of both.

Fertilizer Experiments with Sweet Corn. Joseph A. Chucka and Stephen M. Raleigh. Sweet corn fertilizer experiments were conducted on three farms in 1939. The experiments included a comparison of varying proportions of nitrogen, phosphoric acid, and potash, several rates of fertilizer application, and the effect on sweet corn yields of nitrogen side dressings using different materials and different times of application.

In Tables 4 to 8 is presented a summary of data obtained not only in 1939 but also for the three preceding years.

TABLE 4

*Yields of Sweet Corn Secured with Varying Proportions of Nitrogen, Phosphoric Acid, and Potash. 1936–1937**

Treatment	1936				1937		Average acre yields
	Buxton	Unity	Farmington	Fryeburg	Fryeburg	Farmington	
	Acre yields in pounds of snapped corn						
2–8–4	5218	10018	9311	9946	9051	10055	8933
4–8–4	6226	10908	10164	10418	9819	11168	9784
6–8–4	6554	11072	7823	10055	10134	11265	9484
4–4–4	7512	9402	9130	10346	—	—	—
4–8–4	6226	10908	10164	10418	9819	11168	9784
4–12–4	6529	9601	10781	9765	10545	12173	9899
4–16–4	5016	—	10200	10019	10085	11858	—
4–8–0	6680	9366	9402	9983	9462	11168	9344
4–8–2	6580	10382	8784	11689	—	—	—
4–8–4	6226	10908	10164	10418	9819	11168	9784
4–8–6	5949	10600	8876	9692	—	—	—
4–8–8	6907	9692	8530	11362	9928	11572	9665
4–8–12	—	—	—	—	9263	11725	—

* Fertilizer was applied at 600 pounds per acre. Single plots consisted of four sixty foot rows. All treatments were replicated five times. Fifty feet from the two middle rows of each plot were harvested for yield determination.

TABLE 5

Yields of Sweet Corn Secured with Varying Proportions of Nitrogen, Phosphoric Acid, and Potash. 1938–1939

Treatment	1938						1939	Average acre yield
	New Sharon		Corinna		Fryeburg		Fryeburg	
	Acre yields in pounds of snapped corn*							
4–12–4	5276†	7889‡	9995†	10624‡	10551†	11400‡	11822†	9651
8–12–4	6582	8276	9946	9123	10817	9995	12614	9622
12–12–4	8131	9148	10817	9244	9801	11713	12893	10250
4–8–4	5131	7646	9874	10164	10067	10696	12112	9384
4–12–4	5276	7889	9995	10624	10551	11400	11822	9651
4–16–4	5759	7744	9728	10479	11205	11180	11519	9659
4–12–4	5276	7889	9995	10624	10551	11400	11822	9651
4–12–8	5953	7405	10092	9728	9825	11858	11453	9473
4–12–12	5566	7236	9922	10478	11374	11398	11810	9683

* Single plot consisted of four sixty foot rows. All treatments were replicated five times. Fifty feet from the two middle rows of each plot was harvested for yield determinations.
† Fertilizer was applied at 500 pounds per acre.
‡ Fertilizer was applied at 1,000 pounds per acre.

TABLE 6

Yield of Sweet Corn Secured with Varying Rates of Fertilizer Application. 1936–1939

Treatment*	1936				1937		1938				1939		Average acre yield
	Buxton	Unity	Farmington	Fryeburg	Farmington	Fryeburg	New Sharon	Corinna	Fryeburg	Unity	Fryeburg	West Minot	
	Acre yields in pounds of snapped corn												
No fertilizer	4411	8022	9184	9584	8555	5560	—	—	—	—	—	—	—
150 lbs. 8–24–8	4538	10164	11508	10382	9202	8149	6752	8518	10575	11540	9861	11658	9404
300 lbs. 8–24–8	4890	10800	9692	10908	10007	8095	7405	8289	12221	12375	10001	13080	9814
450 lbs. 8–24–8	5042	10310	12542	12160	10685	9184	8603	9402	13382	14217	10714	12427	10722
600 lbs. 8–24–8	6454	12814	12451	12378	11422	9729	9390	10830	13504	13628	10575	13376	11379

* Single plot consisted of four sixty foot rows of sweet corn. All treatments were replicated five times. Fifty feet from the two middle rows of each plot was harvested for yield determination. The fertilizer was applied in two bands about two inches to the side and slightly below the seed with an Iron Age Corn, Bean, and Pea Planter furnished by the A. B. Farquhar Co.

Tables 4 and 5 show the proportions of nitrogen, phosphoric acid, and potash used in these experiments and the resulting yields of sweet corn in terms of pounds of snapped corn per acre. Except on the low yielding fields there was comparatively little difference in yields among the various treatments used. The proportion of nitrogen, phosphoric acid, and potash which produced the highest yield varied with the soil fertility on the farms upon which the tests were conducted and with seasonal conditions. The two grades of fertilizer that produced highest yields more often than others were 4-12-4 and 12-12-4. On those farms where 12-12-4 produced the highest yields from fertilizer applied at planting time, very good response was obtained also from nitrogen side dressings.

Table 6 shows the amounts of fertilizer used and the yields of sweet corn produced with those treatments over a period of four years. Sweet corn yields tended to increase somewhat with each increase in amount of 8-24-8 applied up to and including 600 pounds per acre of 8-24-8. In these tests the fertilizer was

TABLE 7

*Yields of Sweet Corn Secured with 24 Pounds of Nitrogen from Different Side Dressing Materials**

Year	Location	Check (No side-dressing)	Nitrate of soda	Nitrate of soda-potash	Cyanamid	Sulfate of ammonia	Urea	8–24–8
		Acre yields in pounds of snapped corn						
1937	Farmington	10880	10177	11346	10869	10818	10756	11137
	Unity	8040	8104	8445	8432	8369	8170	8166
	Fryeburg	8095	9426	8585	—	9059	9644	9293
	Farmington	10007	10085	10382	—	—	—	10406
1938	Cornish	11499	12144	11317	12089	10598	11132	—
	New Sharon	7405	10345	10261	—	—	—	—
	Corinna	8289	10188	10188	9257	—	—	—
	Fryeburg	12221	13358	12463	—	—	—	—
	Unity	12357	13794	12902	13840	—	—	13734
	Unity	12856	13325	13734	—	—	—	—
1939	Corinna	10115	10841	11713	10146	—	—	—
	Corinna	10115	11700	10890	10182	—	—	—
	Fryeburg	10001	10999	—	11023	—	—	—
	West Minot	13080	13086	12886	12650	—	—	—
	West Minot	9982	10491	—	12042	—	—	—
Average of 13		10381	11275	11162	—	—	—	—
Average of 10		10436	11152	—	11053	—	—	—

* Single plot consisted of four sixty foot rows. All treatments were replicated five times. Fifty feet from the two middle rows of each plot was harvested for yield determination.

applied in bands two inches to each side and about an inch below the seed. The fertilizer was applied and the corn was planted in one operation with an Iron Age corn, bean, and pea planter which was furnished by the A. B. Farquhar Company.

Table 7 shows the materials compared in side dressing experiments and their effect on sweet corn yields. In all cases these materials were applied by hand by scattering them as uniformly as possible on the surface of the soil between the rows of sweet corn. All materials, with the exception of cyanamid, were applied at the same time for this comparison. The cyanamid was applied approximately a week in advance of the other materials in most cases. In most comparisons the amounts of the materials used were sufficient to supply 24 pounds of nitrogen per acre. In a few cases 48 pounds of nitrogen was applied from the materials com-

TABLE 8

*Effect of Different Amounts of Nitrogen and Different Times of Side Dressing Applications on Sweet Corn Yields. 1936–1939**

Year	Location	Amount of nitrogen		Check (No side-dressing)	Time of application		
		24 lbs.	48 lbs.		Early	Medium	Late
		Acre yields in pounds of snapped corn					
1936	Unity	12542	10698	10790	12542	—	11362
	Fryeburg	11762	10962	10073	11762	—	10062
	Buxton	9642	10348	4916	9642	—	6907
	Farmington	11190	10890	10999	11190	—	11645
1937	Farmington	11054	10710	10880	11054	10177	10475
	Farmington	—	—	10880	10710	10567	10839
	Unity	7965	8292	8040	7965	8104	8313
	Unity	—	—	8040	8292	8061	7817
	Fryeburg	9123	9238	8095	8319	—	9238
	Fryeburg	9426	8319	8095	9426	—	9123
	Farmington	10085	10729	10085	10729	—	10165
1938	Cornish	11550	10986	11499	11550	11853	11192
	Cornish	11853	12144	11499	10986	12144	10702
	Cornish	11192	10702	11499	—	—	—
	New Sharon	10345	11870	7405	11870	—	8095
	Corinna	9583	10188	8289	10188	—	9680
	Unity	12902	13779	12357	13779	—	12508
	Unity	11888	12902	12357	—	—	—
1939	Corinna	10841	11700	10115	11700	—	11205
	Corinna	11713	10890	10115	—	—	—
	Corinna	10146	10182	10115	—	—	—
	Fryeburg	—	—	10001	10999	—	9934
	West Minot	12505	13086	13080	13086	—	11979
Average of 20		10865	10931	10015	—	—	—
Average of 19		—	—	9744	10831	—	10113

* Single plot consisted of four sixty foot rows. All treatments were replicated five times. Fifty feet from the two middle rows of each plot was harvested for yield determination.

pared. In general it may be said that there was comparatively little difference in the effectiveness of the materials used for side dressing. In the majority of cases the increase in yield of sweet corn obtained was considerably more than sufficient to pay for side dressing applications.

Table 8 presents data comparing the use of 24 and 48 pounds of nitrogen (equivalent respectively to 150 and 300 pounds of nitrate of soda) per acre as a side dressing and a comparison of equal amounts of nitrogen applied at different times during the growing season. The side dressing applications consisting of 24 pounds of nitrogen were more profitable than the 48 pounds of nitrogen in most instances. The early applications were applied prior to tasseling in all instances and usually when the corn was about knee high. Those labeled as late applications were applied at the time of silking. In nearly every case the early applications were much more effective than the late applications in increasing sweet corn yields.

Although the data secured during the four years 1936-39 are not very conclusive, nevertheless from them and from farmers' experience the following conclusions might be made relative to sweet corn fertilization in Maine.

1. No particular grade of fertilizer can be selected which will produce best yields of sweet corn under all conditions. The condition of the soil with respect to fertility and the character of the season are apparently important factors in determining which fertilizer will produce the highest yields. In general, however, a fertilizer with approximately a 1-3-1 ratio appears to be satisfactory where the amounts used are comparatively small and where manure has been applied to the field. If no manure has been applied, the amount of fertilizer must be increased and, further, a fertilizer with approximately a 1-2-1 ratio should be more desirable. If the manure used has been reinforced with superphosphate, a fertilizer with a 1-2-1 ratio should be satisfactory.

2. The amount of fertilizer to be applied to sweet corn for most profitable returns varies with a number of factors, such as the fertility of the soil, the amount of manure applied, the method of application, the price of corn, etc. However, under most conditions it appears desirable to apply 400 to 600 pounds per acre of an 8-24-8 or its equivalent to fields which have been manured

and somewhat larger amounts of an 8-16-8 or its equivalent to fields which have not been manured. To apply these amounts of fertilizer at planting time it is necessary to use a planter which permits a satisfactory fertilizer placement. Otherwise the corn will be injured and will not produce satisfactory returns. Proper fertilizer placement for relatively heavy applications presupposes keeping the fertilizer about two inches away from the seed.

3. On low yielding fields, and on all fields where the application of fertilizer at planting time was inadequate, very profitable returns may be secured from side dressing with nitrogen. The particular nitrogen carrier to be used may vary with circumstances but in general is not very important. The amount to be used should be sufficient to supply about 24 pounds of nitrogen per acre. The time of application appears to be rather important and should be made at about the time the corn is knee high and in all cases prior to tasseling. In our experiments no evidence was secured to indicate a delay in maturity as a result of early side dressing with nitrogen at either the 24 or the 48 pounds of nitrogen level.

BEANS. Iva M. Burgess and Russell M. Bailey. *Planting Rate for Snap Beans.* Full Measure snap beans were planted at varying rates from 1 to 6 inches between plants. After the first part of the season, growth was excellent. Highest yields were obtained from the 1 and 2 inch rates. The percentage of No. 1 grade pods did not show any consistent trend with planting rate although that from the 1 inch rate was slightly higher than that from any other rate. Results from the 1939 plot were not fully in accord with those from the 1938 plot. Because of dry weather the growth in 1938 was considerably less vigorous. There was little difference in the total yield from the 1, 2, 3, and 4 inch planting rates, but the 5 and 6 inch spacings gave reduced yields. The 1 inch rate gave the lowest percentage of No. 1 grade pods in 1938 but the highest in 1939. Many of the culls were short crooked pods, possibly indicating that in 1938 the dry season was not favorable to close planting, although when the moisture supply was more abundant, such as in 1939, the thicker plantings were more desirable.

Effect of Frequency of Harvest on the Yield and Grade of Snap Beans. Full Measure beans were harvested at two-day

and at four-day intervals. In 1939 both the total yield and the yield of No. 1 pods was higher from the four-day pickings. The percentage of No. 1 pods was lower from the four-day than from the two-day pickings, the percentages being 71.2 and 81.8, respectively. In 1938 both total yield and the per cent of No. 1 pods were higher from the two-day pickings.

Effect of the Application of Nitrate of Soda on the Yield and Grade of Snap Beans. Nitrate of soda was applied along the rows at blossoming time at the rate of 200 pounds per acre in comparison with similar rows untreated. Harvests were made at two-day intervals. Both the total yield and the per cent of No. 1 grade pods was slightly but not significantly higher from the rows receiving the nitrate. The greatest difference in yield was noted at the second picking.

Bean Breeding. The efforts to develop a slender podded white seeded snap bean for canning was continued in 1939. Both wax and green podded selections are in the process of purification and in the test for quality and adaptation.

Efforts to develop a bush type Yellow Eye of high yield and disease resistance were continued. Crosses involving both bush and runner types and disease resistance have been made. The breeding field was inoculated from diseased material and only the apparently disease-free selections were kept for continuation.

The Mexican Bean Beetle. John H. Hawkins. The Mexican bean beetle is now found over the greater part of Maine. It causes considerable loss in many localities and continues to spread as well as to intensify its attack on the bean crop. The areas of the State where dry beans are grown and where beans are planted for canning have been invaded recently. In these areas considerable damage has been caused by the Mexican bean beetle during the past year.

The problem of Mexican bean beetle control in beans intended for consumption as green beans is in providing protection without injury to the beans and without endangering the life or health of people who ultimately use the beans as food.

Beans are often treated with arsenicals until the pods are formed on the plants after which it is possible to harvest the green beans before great injury by the Mexican bean beetle occurs. Certain forms of arsenic are injurious to beans when used alone

or with other materials. Arsenic of any kind is dangerous to health if left on beans which are used for human consumption. Beans used for dry beans may be treated with arsenicals without endangering human lives as the arsenic adheres to the pods only and the shelled beans are free of the poison. The main consideration where dry beans are to be treated for the control of the Mexican bean beetle is in finding a material to be used with calcium arsenate since calcium arsenate, which furnishes protection to the beans, cannot be used alone without causing injury to the plants and reducing the yield of beans.

In any case where beans are to be treated before the pods are formed, the crop can be treated with calcium arsenate. Experiments have been outlined with the idea of developing a cheap insecticide for green beans up to the pod stage and for application to beans grown for the dry bean crop. Experiments carried on during previous years have shown that rotenone may be used after pods have been formed on the bean plants without endangering humans or injuring the beans. Rotenone is especially useful to the home gardener and in treating small areas in canning beans where it is desirable to clean up infested areas to prevent spread of the Mexican bean beetle. Rotenone is almost equally, if not entirely, as effective as calcium arsenate in the control of the Mexican bean beetle. It is somewhat more expensive than calcium arsenate and does not remain effective as long as the arsenate.

The following figure (Figure 3) shows the results of treating beans with calcium arsenate and magnesium arsenate as the active insecticidal ingredient used for Mexican bean beetle control. Magnesium arsenate has long been the standard insecticide used for this purpose. The cost of magnesium arsenate has been a limiting factor in its use and calcium arsenate has been generally substituted for it. The danger from the use of calcium arsenate is that foliage injury and a reduction in yield are likely to result when calcium arsenate is applied under certain conditions and with certain other materials. Previous work on the problem has shown that an increase of yield resulted when magnesium arsenate, or calcium arsenate combined with magnesium, was used.

Yields represented by the bars in Figure 3 represent yields in dry beans harvested from experimental plots in 1939. In all cases four treatments were applied to the beans at approximately

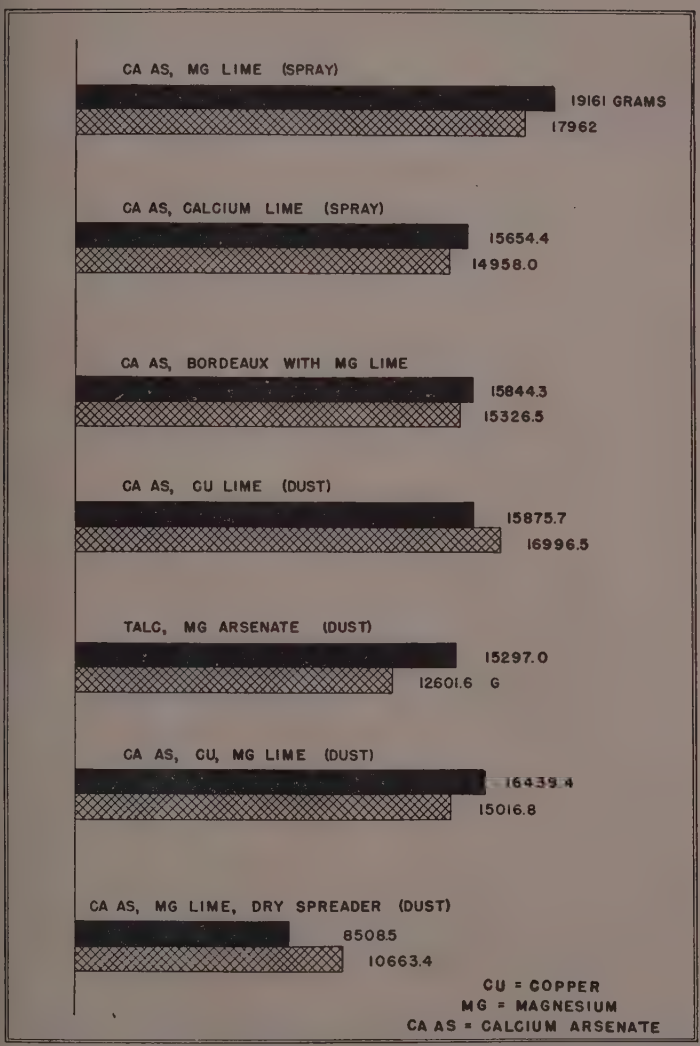

FIG. 3. The weight in grams of dry beans obtained from plots treated with insecticides for the control of the Mexican bean beetle. The solid black bars represent approximate weights of dry beans obtained from treated plots. The cross-hatched bars represent the weight of dry beans from the untreated check plots. The figures at the top of the bars represent the actual weight of the dry beans obtained from treated and untreated plots.

ten-day intervals beginning July 19. Plots treated with calcium arsenate, used at the rate of 3 pounds with 3 pounds of magnesium bearing lime in 100 gallons of water, produced a yield of 19,161 grams of dry beans. The yield from untreated check plots was 17,962 grams. Comparative yields are shown also, as before expressed in terms of grams of dry beans, from the treatment of calcium arsenate used in the same way as the treatment represented above except that the lime used was free of magnesium. The third comparison represents the weight of beans from plots in which the treatment was with Bordeaux and magnesium lime combined with calcium arsenate, the formula being 4 pounds of copper sulfate, 4 pounds of magnesium lime, and 50 gallons of water containing 1½ pounds of calcium arsenate and the weight of beans from the untreated check plots. The fourth comparison represents the weight of dry beans from plots treated with calcium arsenate 1 part to 9 parts of 20-80 copper lime dust contrasted with the weight of dry beans from untreated check plots. Contrary to the results of previous years, the yield from the check plots exceeds that from the treated plots. The sixth comparison shows the same treatment as is represented in the fourth comparison except that the lime used in the copper lime dust contained magnesium. The treated plots yielded a substantial gain of 1,422.6 grams more than the untreated plots. The fifth comparison represents the yield of dry beans from plots treated with magnesium arsenate and shows the greatest increase in the weight of dry beans for any given series of treated plots as compared with corresponding check plots. The seventh comparison represents the weight of dry beans from plots treated with a dust containing 1 part of calcium arsenate to 9 parts of magnesium lime to which was added a 1 per cent spreading and wetting agent. Here a reduction in yield was obtained as compared with the weight of beans obtained from the untreated check plots. This reduction in yield corresponds to results from experiments of previous years, in which substances were used to stick materials, containing calcium arsenate, to beans.

TOMATOES. *Date of Planting.* Iva M. Burgess. Canadian, Field Station 22, Shirley Bonny Best, Pritchard, Marglobe, and Rutgers tomatoes were planted at weekly intervals from March 30 to April 26 inclusive. All lots were set in the field June 8. In

all cases the earliest planted lots yielded the earliest, but the early yield from the second planting (April 5) was superior to that from the first planting both in amount and quality. Later plantings from all but Marglobe and Rutgers yielded more ripe fruit for the season than did the first two plantings. Early yields from the earliest planting of Canadian and of Field Station 22 were of no value because of their small size and severe cracking. These results are in accordance with those obtained in 1938 in that the crop from an early yielding variety such as Canadian can be damaged by too early planting before setting. Later yielding varieties may be damaged slightly by early planting but on the whole may give more profitable crops from the earlier started plants if these are kept in a good growing condition.

Tomato Breeding. Iva M. Burgess. Crosses have been made in an effort to produce tomatoes early enough to ripen a good crop in northern Maine. The most promising for earliness involves Farthest North and Pritchard. From this material some rather promising early maturing selections have been made.

Selections from crosses of Pritchard and Shirley Bonny Best with a somewhat "crack-resistant" strain of Red River show promise of being early and of good quality and are being compared with early commercial varieties.

CUCUMBERS. *Breeding Cucumbers Resistant to Scab (Cladosporium cucumerinum).* Russell M. Bailey and Iva M. Burgess. One selection, Maine No. 2, although inferior to most commercial varieties in type, exhibits a high degree of resistance, and most growers find it satisfactory for home gardens where scab is troublesome. A new white spined selection which has better shape and color than Maine No. 2 was sent to 40 growers for cooperative trial this year. Numerous new selections for resistant pickle and slicing types were made during the past year. Genetic data concerning inheritance and linkage relations with some other characters are being accumulated.

Insecticides for the Control of the Striped Cucumber Beetle, Diabrotica vittata. John H. Hawkins. Previous experiments with insecticides indicated that lime containing magnesium caused less burning on cucumbers than was caused by magnesium-free lime. The weight of cucumbers from plots treated with magnesium lime yielded 10.82 pounds on the basis of 10 hills as compared

with a yield of 9.45 pounds per 10 hills from plants treated with magnesium-free lime. In both cases the lime was used at the rate of 20 parts to 1 part of calcium arsenate. Several hills of cucumbers were killed outright in the untreated plots and, if these were to be included, the average yield of cucumbers from untreated plots was considerably less than the yield from those treated with either magnesium or hydrated lime, 20 parts to 1 part of calcium arsenate.

Protection of young cucumber plants from the striped cucumber beetle is essential. Cucumber seedlings are especially susceptible to injury up to the time runners are formed on the plants. Squash planted in the vicinity of the cucumber experiment attracted large numbers of the striped cucumber beetles. This in a measure served as a protection for the cucumber plants at the time the plants were breaking through the soil and shortly afterward. This suggests the possibility of using squash as a trap crop for cucumbers. After the beetles have concentrated on the squash, a strong contact spray of nicotine or pyrethrum may be used for destruction of the beetles. Squash used as a trap crop for the protection of cucumbers should regularly be treated to kill the beetles to prevent their accumulation and breeding in the vicinity.

SPINACH. *Seed Treatment.* Iva M. Burgess. Growers in the southern part of the State have had considerable experience with poor stands of spinach from summer plantings. Examinations indicated that this was at least partly due to damping off. A plot using different seed treating materials was planted on July 27. The results obtained were as follows:

Treatment	Total Emergence	Plants Died	Per cent Died	Final Stand
Red Copper oxide	403	96	23.8	307
"Copper Compound"	293	115	39.2	178
Zinc oxide	215	75	34.9	140
Semesan	253	117	46.2	136
Check	68	31	45.6	37

VEGETABLE VARIETY TRIALS. Iva M. Burgess and Russell M. Bailey. Variety trials of lettuce, cabbage, sweet corn, spinach, carrots, tomatoes, snap beans, edible soybeans, peppers, eggplant, muskmelons, watermelons, and small squash were grown at High-

moor Farm in Monmouth and on several privately owned farms in Cumberland and York counties. Results of this work have been published in bulletin form as Miscellaneous Publication No. 560.

Squash. *Experiments with Insecticides for the Control of the Squash Bug, Anasa tristis* De Geer, John H. Hawkins. The squash bug, once rarely found in Maine, has now become a problem to those growing squash in this State. A great many insecticides have been tried and most have proven impractical. Recently, stabilized pyrethrum has been reported as effective in the control of the squash bug. Squash from plots treated with dust containing 20 parts of magnesium lime and 1 part of calcium arsenate for the control of the striped cucumber beetles followed by three treatments of stabilized pyrethrum for the control of the squash bug yielded an average of 22.76 pounds per hill as contrasted with a yield from untreated check plots of 13.44 pounds per hill. Plants treated with a dust containing 20 parts of magnesium-free lime, 20 parts to 1 part of calcium arsenate, and given three later treatments with stabilized-pyrethrum dust yielded an average of 15.45 pounds of squash per hill as contrasted with a yield of 13.67 pounds of squash per hill from untreated hills. Squash planted in the vicinity of cucumbers were more heavily infested by the striped cucumber beetle than were the cucumbers. Consequently, it is imperative that the squash planted near cucumbers be protected from the striped cucumber beetle, especially early in the season until the young squash plants are well started.

Pea Aphid Investigations. John H. Hawkins. Pea aphids were present in canning peas in comparatively small numbers during the 1939 season. Appreciable injury occurred only in a few pea fields. An increase in the intensity of population and a spread to other fields seemed certain, when suddenly a disease killed great numbers of pea aphids and put an end to the threatened pea aphid outbreak.

Pea aphids were found on clover during the fall of 1939 and again in late May and early June of 1940. Early peas were very lightly and late peas only slightly more heavily infested up to July 1. Parasites and predaceous insect enemies played an important part in keeping the pea aphids from reaching outbreak proportions. The most important natural factor in pea aphid con-

trol was a disease which attacked and killed almost the entire aphid population within a relatively short time. This disease, which has been thought to be caused by a fungus, works very quickly and effectively after the aphids are sufficiently abundant so that there is bodily contact between them.

The relation of aphids to their environment has been studied and certain important relations of the abundance of aphids to weather have been found. In general, wet cold weather is not conducive to large pea aphid populations. Warm fair weather is favorable to aphids and to many of their predaceous and parasitic insect enemies. What is usually spoken of as hot weather is especially favorable to pea aphid abundance, and it is during such weather that outbreaks usually occur in Maine. Warm humid weather is favorable to pea aphid abundance and is also favorable to the disease which kills the aphids in great numbers. Such data are of general interest and may prove of value when information has been accumulated over a period of several years, although at the present time it is impossible to base accurate forecasts of aphid

TABLE 9

Summary of Results with Insecticides in Pea Aphid Experiments at Monmouth, Maine, During 1939

Insecticide material used	Numbers of pea aphids taken per 10-sweep sample	
	Before treatment	After treatment
*Rotenone 1%, talc 98%, sodium oleyl sulfate 1%. Eight plots treated.	1882	146
No treatment, eight plots.	1892	432
Rotenone 1%, talc 98%, Santomerse 1%. Eight plots treated.	2425	779
No treatment, eight plots.	2153	1275
Rotenone 1%, talc 93%, sodium lauryl sulfate 1%, terpene ethers 5%, colored green for stabilization against sunlight. Five plots treated.	1436	308
No treatment, five plots.	1530	765
Rotenone 1%, talc 93%, sodium lauryl sulfate 1%, terpene ethers 5%. Six plots treated.	1595	280
No treatment, six plots.	2117	264

* Ground derris root of 4 per cent rotenone content was used as the source of rotenone in these experiments.

abundance on ecological studies. This is because of the lack of sufficient data and because local weather conditions cannot be forecast with certainty very far in advance.

Insecticides used in pea aphid control experiments were difficult to evaluate because the disease recorded in a foregoing paragraph destroyed many aphids in both treated and check plots. It was impossible to tell in some of the plots whether the insecticide or the disease was the most important factor in the control of the aphids. The results given in the following table (No. 9) are of actual counts of pea aphids.

The peas were dusted July 11, 1939. The temperature during the time when the dusts were applied ranged from 60 to 64° F. The following day a light shower occurred and the temperature was somewhat higher, ranging up to 71° F.

The sudden destruction of the aphids by disease so complicated the problem that a comparison of the materials tried, other than those listed in Table 9, could not be made with the untreated plots. The aphids had begun to die at the time treatments were applied and within a few days aphids in both treated and untreated plots were almost all dead. The following materials in addition to those listed in Table 9 were used in the experimental plots on peas in pea aphid control experiments.

Rotenone and oil
Rotenone, oil, and nicotine
Pyrethrum and rotenone
Two commercial brands of rotenone dust
Nicotine and oil
Rotenone spray.

Rotenone insecticides were slightly more effective in the control of pea aphids during 1939 than during 1938. Probably this was partially due to changes in temperature and partly to improvement in the insecticides themselves.

Cutworms and Army Worms Affecting Field and Garden Crops. John H. Hawkins. Cutworms caused material damage to field and garden crops in certain sections of Maine during the past year. Army worms caused considerable injury to grain in isolated areas but, over the State as a whole, the army worms were less prevalent than during the previous season.

Cutworms and army worms are the young, caterpillars, or

larvae, which hatch from eggs laid by the moths of the cutworm family. The cutworm family, Phalaenidae, includes all the cutworms and army worms injurious to the field and garden crops of Maine. Collecting and rearing of the moths and their larvae have revealed that there are 300 or more species of this destructive family present in Maine. Many species of this family are known to feed upon vegetation, and they vary greatly in their habits. Some are the well-known cutworms which cut off plants at or near the soil surface, and are pests of field and garden crops. Cutworms also climb up and eat the foliage, fruit, or buds of many kinds of plants, including many kinds of crops and fruits. Certain species of larvae attack the fruits and foliage of shade and forest trees and of ornamental shrubs. Other larvae of Phalaenidae live as borers inside the stems or stalks of plants, and several species feed inside or on the fruit or seeds of plants. Some six or eight species feed in corn ears. Two species of army worms, permanent residents in Maine, move in great numbers upon fields of grain or other crops and destroy everything upon which they are able to feed, while a migrant from the South, the fall army worm, often appears in corn in August and September.

The maintenance of traps and field investigations over a period of years has provided information on the numbers and kinds of moths of the family Phalaenidae which are present. Large numbers of any given species taken at the traps indicate the possibility of a cutworm or army worm outbreak arising from these moth flights, and such readings provide advance information which often proves of value in attempts to control the larvae.

During the past year new specimens have been added to the Station collection of Phalaenidae with a view to making the collection more useful in the identification of army worm and cutworm moths. Progress is being made also on the rearing, collecting, and preservation of army worms and cutworms in their larval or caterpillar stage. Such a collection and information accumulated with the collection makes possible the identification of many species of destructive cutworms, army worms, and their near relatives which attack the garden and field crops of Maine. The life history and habits of individual species in this group vary. Therefore, it is necessary to know what particular species is concerned before plans for control measures can be effectively made.

The use of poison bran bait has proven satisfactory in the control of many species of army worms and cutworms. The use of rotenone dust also has proven satisfactory in some cases where cutworms and army worms were attacking corn or grain. A general clean-up of all crop remains and the destruction of nearby dead grass and weeds late in the fall or early spring are known to be effective in the control of cutworms and army worms as well as the borers of the family Phalaenidae which attack corn. The practice of a short crop rotation and cultivation is also of value in the control of these insects.

CHEMISTRY

Work of Investigation. Elmer R. Tobey and Bernie E. Plummer, Jr. The work of this department is cooperative with members of other departments in the Station and includes the chemical analyses in connection with some of the resarch projects. The results of these analyses are incorporated in the published reports of the respective Station research projects.

Chemical Analyses in Connection with the Problems of Nutrition and Growth of Poultry and Dairy Cattle. (In cooperation with the Department of Biology.) At the present time about sixteen samples of milk from the dairy herd at Highmoor Farm are received each week for analysis. Samples of the ingredients used in making the rations for the experimental work with dairy cattle and poultry and samples of silage are received from time to time.

Soil Analyses Investigation and Analysis of Materials used in Connection with the Permanent Rotation and Fertility Experiments at Aroostook Farm. (In cooperation with the Department of Biology.) During the last year the work on this project has consisted in the analysis of the ingredients used in making the fertilizer mixtures for use on the experimental plots. Also in connection with the 1939 Pot Experiment carried on by Dr. Chucka, the determinations of the amounts of plant nutrients removed from Caribou loam by leaching with water were made. Three fertilizer mixtures (4-8-4, 4-8-12, and 4-8-20) were used.

Spray Residues on Apples. (In cooperation with the Department of Entomology.) During the last year eight samples of

sprayed apples from the experimental plots were received for analysis. These apples were examined for the amounts of both lead and arsenic in the spray residue.

Strength of Mercuric Chloride Solutions Used in the Treatment of Seed Potatoes. (In cooperation with the Department of Plant Pathology.) This investigation has been continued since 1937. In addition to the usual hydrochloric acid dip solution, an acetic acid dip solution was tried. Acetic acid was suggested because it is not as corrosive as hydrochloric acid and can be used in higher percentage strengths of acid without any danger of burning of the seed piece. Fifty-two samples of acid dip solutions used at Aroostook Farm were received for analysis. No additional mercuric chloride was added to the dip solutions during the treatments. The results of the analyses are reported in the following tables.

TABLE 10

One Per Cent Hydrochloric Acid, Two Parts per Thousand $HgCl_2$, Aroostook Farm 1939

(Analyzed June 19, 1939)

Treatment	HCl per cent	$HgCl_2$ P.P.T.
Solution before treatment	0.511	2.4285
" after 1st "	0.511	2.4150
" " 2nd "	0.511	2.4080
" " 3rd "	0.492	2.3915
" " 4th "	0.492	2.3860
" " 5th "	0.492	2.3640
" " 6th "	0.474	2.3585
" " 7th "	0.474	2.3430
" " 8th "	0.474	2.3170
" " 9th "	0.456	2.3310
" " 10th "	0.474	2.3055
" " 11th "	0.474	2.3140
" " 12th "	0.438	2.2830
" " 13th "	0.456	2.2650
" " 14th "	0.456	2.2450
" " 15th "	0.438	2.2150
" " 16th "	0.438	2.1980
" " 17th "	0.420	2.1825
" " 18th "	0.420	2.1785
" " 19th "	0.420	2.1505
" " 20th "	0.420	2.1215
" " 21st "	0.401	2.0990
" " 22nd "	0.401	2.0915
" " 23rd "	0.401	2.0685
" " 24th "	0.383	2.0590
" " 25th "	0.383	2.0320

Note: The pH of the dip solution was 1.15 at the beginning of test and also 1.15 after the 25th treatment.

TABLE 11

One Per Cent Acetic Acid, Two Parts per Thousand $HgCl_2$, Aroostook Farm 1939

(Analyzed June 21, 1939)

Treatment	Acetic acid per cent	$HgCl_2$ P.P.T.
Solution before treatment	1.74	2.1745
" after 1st "	1.80	2.1535
" " 2nd "	1.80	2.1370
" " 3rd "	1.80	2.1495
" " 4th "	1.77	2.1430
" " 5th "	1.77	2.1365
" " 6th "	1.74	2.1230
" " 7th "	1.77	2.1255
" " 8th "	1.80	2.1010
" " 9th "	1.77	2.1010
" " 10th "	1.77	2.0990
" " 11th "	1.74	2.1020
" " 12th "	1.74	2.0935
" " 13th "	1.71	2.0880
" " 14th "	1.74	2.0675
" " 15th "	1.74	2.0715
" " 16th "	1.74	2.0675
" " 17th "	1.71	2.0430
" " 18th "	1.71	2.0390
" " 19th "	1.71	2.0245
" " 20th "	1.68	2.0390
" " 21st "	1.71	2.0145
" " 22nd "	1.71	1.9965
" " 23rd "	1.71	2.0000
" " 24th "	1.71	2.0015
" " 25th "	1.71	1.9970

Note: The pH of the dip solution was 3.1 at the beginning of test and also 3.1 after the 25th treatment.

The Conservation of Ammonia in Manure. Elmer R. Tobey, Bernie E. Plummer, Jr., and Delmar S. Fink. The problem of ammonia conservation in manure was first attacked in 1939 by the use of peat bedding in comparison with sawdust bedding and the addition of 20 per cent and 47 per cent superphosphate to manure in the gutter daily. The cows at the Experiment Station Farm, Highmoor, were used. These cows were divided into six groups of three cows each. The six groups received respectively (1) sawdust bedding only, (2) peat bedding only, (3) sawdust bedding plus 20 per cent superphosphate, (4) sawdust bedding plus 47 per cent superphosphate, (5) peat bedding plus 20 per cent superphosphate, and (6) peat bedding plus 47 per cent superphosphate. The manure was stored in separate compartments in the pit and samples were taken at frequent intervals and analyzed for pH, moisture, total nitrogen on the fresh manure, and

total nitrogen on the manure after air drying. By these analyses it was possible to determine how much, if any, nitrogen could be conserved by the use of superphosphate.

Besides the experiments conducted at Highmoor Farm a number of experiments were set up and conducted in the laboratory. Samples of fresh urine and feces were collected from the University herd, mixed in proportions ordinarily occurring in manure and with the recommended amount of either sawdust or peat bedding. Both 20 per cent and 47 per cent superphosphate were used in some of these experiments as well as varying amounts of sulphuric acid, sulfamic acid, phosphoric acid, and molasses. The different samples were stored in gallon earthern crocks and the moisture maintained constant by adding water at frequent intervals. The pH and total nitrogen on the fresh and air dry manure were determined on all samples at the beginning of each experiment and at frequent intervals for a period of time extending over several months with some of the experiments.

The amount of ammonia which superphosphate alone and superphosphate with the addition of gypsum were able to conserve on air drying at different pH's was investigated.

The results of these experiments thus far indicate that while peat is a very good absorbent and bedding material it does not conserve any appreciable amount of ammonia.

The addition of 20 per cent or 47 per cent superphosphate to manure in our experiments did not prevent the loss of ammonia by volatilization. Both the 20 per cent and 47 per cent superphosphate with and without gypsum when mixed with ammonia and not used with manure were able to prevent the volatilization of ammonia under acid conditions, but when a sufficient quantity of base was added to bring the pH up to that of manure (8.0 to 8.5) practically all of the ammonia was lost on drying.

The addition of sulphuric acid, sulfamic acid, and phosphoric acid were all effective in conserving ammonia in manure if added in sufficient quantities to lower and maintain the acidity of the manure at a low pH (3.0 to 3.5). The addition of such large amounts of acids in the barn, however, is not practical or economically feasible. Molasses can be added in quantities sufficient to produce by fermentation enough acid to conserve all the ammonia

in manure. The cost of the molasses required is too great in comparison to the value of the ammonia saved to be of practical use.

In October 1939 two sets of experiments were set up, one at Highmoor Farm and the other at the University of Maine dairy barns. The experiment conducted at the University consisted of two groups of three cows each. One group received a daily application of 20 per cent superphosphate in the gutter; the other group received none. Both groups received sawdust or shavings for bedding. The manure was stored in separate piles outside in the open. Every three weeks all of the manure in the gutter was mixed thoroughly, a sample taken for immediate analysis and a weighed sample, contained in a burlap bag, deposited in the pile outside. The fresh samples were analyzed for pH, total nitrogen on fresh manure and after oven drying, moisture, potash, and phosphoric acid. A similar analysis will be made of the contents of the buried bags when the manure is hauled onto the land in the spring.

In the experiment at Highmoor, three groups of three cows each were used. One group received sawdust bedding with no superphosphate, one sawdust bedding plus 20 per cent superphosphate, and the other peat bedding without superphosphate. About the 20th of January, 1940, the use of peat bedding was discontinued, and two groups receiving sulphur in different amounts were started. The experiment at Highmoor is being conducted the same as the one at the University except that the manure is being stored under cover in the pit instead of out in the open. All samples are being analyzed every three weeks and the contents of the buried bags will be analyzed when the manure is hauled out in the spring.

It is hoped that the results of these experiments may not only give additional information on the conservation of ammonia but also information in regard to the changes in potash and phosphoric acid content of manure stored inside and out in the open.

DAIRYING

An Economic Study of the Dairy Industry in Maine. George F. Dow. *Dairy Farm Organization and Management*

Studies. A manuscript based on a study of 214 dairy farms in central Maine for the year ending April 30, 1937, has been prepared by Dr. Emil Rauchenstein of the United States Bureau of Agricultural Economics in cooperation with the Maine Agricultural Experiment Station. This manuscript may be published during the coming year.

Considerable progress also has been made in the detailed analysis of the business of 989 dairy farms located in various areas of the State, for years of both low and high prices. This study will show the effect of many factors on dairy farm profits under widely different conditions such as milk versus cream, different combinations of farm enterprises, high versus low prices, and differences in size of business, yield rates, and labor efficiency. Special problems being analyzed include the quality of pastures and effect on feed costs, dairy cow replacements, seasonal variation in production and in methods of achieving more uniform production, methods of controlling surplus milk, cost of keeping herd bulls versus hired service, and advantages of breeding cows of higher milk production capacity.

Milk Marketing in Maine. The study of the supply and use of milk in local Maine markets under State Control has been published as Bulletin 399, "Receipts, Utilization, and Prices of Milk and Cream in Maine Milk Control Areas," March, 1940. A somewhat similar study for milk and cream shipped from Maine to Boston was started late in the year to determine marketing developments during the past ten years since the publication of Bulletin 367, which included data on milk and cream sales in 1928.

Milk Marketing in New England. In cooperation with Alan MacLeod of the New England Research Council on Marketing and Food Supply, the United States Bureau of Agricultural Economics, and the six New England Agricultural Experiment Stations. The information for a study of New England country milk plants has been analyzed except for a few minor points, and a report is being prepared. This report will include a description of the present location, size, and type of country milk plants in New England, trends in plant size and type during the past 15 or 20 years, and a study of the efficiency in operation. Present plans call for a mimeographed report to be issued by the New England Research Council.

Another phase of this work is the Supply Side of New England Milk Markets. A report is being prepared which will bring together the results of studies made in the various states so as to show the entire milk supply picture for New England.

FAMILY ECONOMICS

How Maine Families Finance Higher Education. Pearl S. Greene. Analysis of the 1938 data has continued. The families studied were those living in Maine, outside the area where commuting was possible, and, with a few exceptions, unbroken families with one student only who is a student at the University in one of the upper classes. These students constituted nearly one-half of the total number of students registered, whose families fell in this fourfold classification. The distribution was state wide geographically, but there is a little evidence to show that families omitted because they were not at home when the interviewer called included a slightly larger proportion of higher income families, so that the group is probably not perfectly representative. The findings therefore can be considered factual for the families studied, and representative for the two lower income classes but not for the proportion in the various income groups or for the upper income group, where average income may be above that of the sample and trends indicated as correlated with income may be more pronounced than was shown in the sample.

Expenditures included all costs which could be included as chargeable to education, such as direct tuition, fees, and total maintenance during the school year. Tuition was fixed and equal for all, but it constituted little more than one-fourth to one-fifth the average total cost for students from various income-groups. Room and board varied considerably; travel, clothing, books, and incidentals varied greatly. It was to be anticipated, consequently, that student costs would not vary as widely as family income, and that therefore they would represent a higher ratio to lower incomes than to higher. This proved to be the case. In the 23 per cent of cases where the family income was below $1,250, student expenditures averaged $579 with 50 per cent spending between $500 and $675. For the 37 per cent in the next income group ($1,250

to $2,249) expenditures averaged $670 with a spread between $590 and $750 for the middle half, while in the 40 per cent of cases with incomes above $2,250 expenditures averaged $751, with 50 per cent of the students spending between $633 and $850.

However, when the total expenditures were analyzed into their sources, classified as self help, debt, special advantage, and direct family contribution, the amount of the last bore a much closer relationship to the family income. In the lowest income group it averaged only $211, 36+ per cent of the total, and was less than the average of $230 (40 per cent) for self help. Debt and special advantages (gifts from friends or relatives other than parents, scholarships, etc.) were nearly equal to each other, and together constituted 23+ per cent of the total. At the next level, family help averaged higher both in amount ($388) and in percentage (58 per cent) with self help smaller ($162, 24 per cent) and the sum of special advantages and debt was 18 per cent. At the highest level (above $2,250), family help again increased in amount and proportion ($593 or 80 per cent), self help again decreased ($114 or 15 per cent) and the remaining sources constitute but 5 per cent of the total.

Since college education, even when only partly supported by the family, is a difficult burden, it is of interest to discover how expenditures, self help, and family help vary for students classified according to their success in college as this may be measured by cumulative grade point average. Superior students (3.00+ grade point average) constituted 21 per cent of the students from the lowest income families, 26 per cent from the middle group, and 8 per cent from the upper group, while inferior students (below 2.00) constituted 21 per cent, 19 per cent, and 24 per cent, respectively, of the three groups.

Superior students (those with cumulative grade point averages 3.00 or higher) from different income levels did not differ as much in expenditure averages as did inferior students (those with averages below 2.00). The former averaged $579, $594, and $700, the latter $536, $682, and $789, while the intermediate group in scholarship averaged intermediate in expenditures of $597, $682, and $743. But at the first two levels, superior students' self help of $249 and $282 ran 38 per cent and 128 per cent higher than that of inferior students. Those of intermediate scholarship

averaged intermediate earnings. Family contributions to inferior students at the lowest level were 38 per cent less than those to superior students ($169 as compared to $216) but at the next level were 95 per cent higher ($416 compared to $213) and at the highest level 39 per cent higher ($663 as compared with $476). Family contributions to students of intermediate scholarship, $225, $438, and $581, were a little above that to either of the other groups except at the highest income level, where they were intermediate.

Students tended to vary somewhat in their expenditures and sources of income, with their position in the family. Only children constituted 15 per cent of the total, oldest 32 per cent, and younger 53 per cent, with approximately similar proportions in each income group. Younger children spent somewhat less, helped themselves more, and had less family help, than only and oldest children. For the former, total expenditure, self help, and family help averaged $658, $176, $403, respectively, for the latter $694, $139, $452. Differences varied in the same direction in each income group. Older children in general differed in the same way from only children, but differences were smaller and less consistent.

Women students' expenditures ran closely parallel to men's, except at the lowest income level where the average of the few cases (9) of women's expenditure ran 12 per cent lower than men's. At every level, women's earnings averaged less than men's, both because individual earnings were less and because the proportion of women who earned was smaller. Of the men 76 per cent helped themselves; of the women, 55 per cent. For both sexes the proportions helping themselves diminished as family incomes increased, from 94 per cent and 67 per cent respectively for men and women from the lowest income families to 72 per cent and 55 per cent at the highest level. The average amount from self help was $159 for all students studied here; the men averaged $184 and the women $64. The average amount from self help, considering only those students who helped themselves, was $221; here the men averaged $241 and the women $157.

HOUSEHOLD EQUIPMENT. Merna M. Monroe and Pearl S. Greene. *The Effect of the Method of Heat Application, and Accompanying Oven Conditions, upon Flavor and Texture of*

Baked Foods. The work has been concerned this year with the effect of water vapor in the oven. Homemakers believe that the steam which escapes from foods during baking prevents browning of batters and doughs. In some electric ovens with thermostatic control, it is true that batters may not brown on top as much when baked in a loaded oven as when baked alone. The writer believes that this lack of browning is caused by insufficient heat reaching the food in the loaded oven, either because of inadequate circulation of ample heat supplied or because the oven has not been built with the capacity to provide enough heat to bake a load which loses considerable moisture. Consequently, tests have been devised to obtain similar oven temperatures when the baking was done with and without added water vapor.

The rate at which water vapor is added to the oven atmosphere can be easily measured; but, since the oven is not air-tight and since the vapor can and does escape at several points, no attempt has been made to measure the rate at which it escapes. Instead, an attempt has been made to estimate the amount of water vapor present at a given time by measuring the dewpoint temperature. A precise measurement of the dewpoint temperature in the heated oven has not been perfected. However, since the rough measurement used gave results agreeing within a few degrees from time to time, these temperatures are being used to explain the results obtained.

Dewpoint temperatures were measured when the oven was maintained at a given temperature and the steam was admitted at different rates; these temperatures were also measured when the steam was fed at a constant rate to the oven maintained at different baking temperatures. These measurements were in agreement with physical principles; *i.e.,* the dewpoint temperature increased when the steam was fed at a faster rate (or when more steam was present in the oven atmosphere), but remained constant when the temperature of the oven atmosphere was increased.

The dewpoint temperature was always below 212° F., as would be expected since saturation cannot be obtained in an oven atmosphere when held at normal baking temperatures and at atmospheric pressure.

The relative humidities calculated on the basis of the rough

dewpoint measurements show that generally the relative humidity of the heated oven is less than 10 per cent.

To obtain a constant thermal load which would not rise to an unpredictable height during heating as would leavened batters and doughs, wet sand was heated instead of food. Pans of wet sand with thermocouples inserted to measure interior temperatures were heated when steam was and was not added to the oven. No difference was obtained in the rate of heating. Calculations showed that the thermal capacity of the atmosphere, whether "moist" or dry, in this small oven was but a small fraction of the thermal capacity of the wet sand, or of most foods which are baked in the oven. Thus the water vapor in the oven cannot be expected to permit faster cooking because of its higher thermal capacity.

No difference was obtained in the loss in weight of foods during baking at similar oven temperatures with steam added and with no steam added to the oven. Since the relative humidity of the oven atmosphere is roughly calculated to be less than 10 per cent, it is probable that sufficient vapor cannot be retained in the heated oven to affect the rate of drying appreciably.

The presence of water vapor in the oven atmosphere does not prevent browning if the oven temperatures are similar to those existing when no steam is added; but the water vapor may or may not have a deleterious effect on certain batters, in that certain batters rise in a peak and split. This rising in a peak and splitting of batters when steam is admitted to the oven prior to and during baking apparently depends on the richness or "leanness" of the batter, and perhaps on other factors. Muffins and less-rich batter cakes rose in a peak and spilt; rich butter cake did not peak or split. Refrigerator cookies, pie crust, and yeast bread showed no deleterious effect when baked in the oven with added steam present. The effect on baking-powder biscuits was a splitting in wide, lateral fissures.

The presence of water vapor in the oven atmosphere hastened the baking of custards and the heating of water, in contrast to the time required for such heating when no steam was added to the oven.

There was a longer period of condensation and larger drops of condensation of oven vapor on the exposed cold food and cold

container when water or custard was heated than when batters were baked.

The use of one vent as was originally built in the electirc oven is not sufficiently effective in reducing the vapor content of the oven. Cross ventilation of the oven, obtained by making some one-inch holes in the bottom and top walls, resulted in a lower dewpoint and in lower oven temperatures. When the steam was fed at a relatively slow rate, this cross ventilation was sufficient to permit the baking of muffins without their splitting.

The homemaker frequently includes hot breads in an oven meal and may prepare a cheap, cake type of dessert in order to use as much oven heat as possible. A poorly shaped product may result when lean batter mixtures are baked in the presence of water vapor, which would be given off by watery and exposed foods normally baked in an oven meal.

A Study of the Performance of Wood Ranges Heated by Distillate Burners and an Evaluation of Factors Which Affect Their Performance. Instructions for installation of oil burners in wood ranges sometimes specify that the burners be so placed as to provide a vertical distance of 1½ to 3 inches between the tops of the burner sleeves and the top of the oven. In some households the burners have been placed higher than this with the idea that faster heating might be obtained.

To note the effect of burner position on stove temperatures, the burners in the cast-iron range, tested last year and reported in Bulletin 397, were raised 2¼ inches. As originally installed by the dealer, the tops of the burner sleeves were 2¾ inches below the level of the top of the oven shell and 5¼ inches below the undersides of the stove lids. In the raised position, the burners were only ½ inch below the top of the oven shell. The oil-bottle stand was adjusted to maintain the same depth of kerosene in the burner bowls as before, or 3/16 of an inch.

With the burners in the higher position, more time was required to preheat the oven, particularly to preheat to a temperature higher than 400° F., than was true with the burners as originally installed by the dealer. The maximum temperature obtainable with the valves for both burners set at the highest operating position was more than 30° F. lower than was obtained with the burners in the original position. Water was heated in less time

with the burners in the higher position when the heating was begun with the lighting of the burners; but, when the tests were made with the stove previously heated and maintained at a steady temperature, no significant difference was observed. Neither was there a significant difference in the rate of kerosene consumption with the burners in the low and in the high position.

A "cheap" steel range, with burners built in, was purchased and is being tested in the same manner as the cast-iron range. This low-priced, steel range has a smaller cooking top than the more expensive cast-iron range; there is not sufficient space for two utensils of 8½ inches over-all diameter to be placed on two adjacent stove lids. Neither is there a damper to regulate the flow of cold air to the firebox. The air enters the firebox at the rear; this tends to cool the burner sleeves facing the cold air entry so that no flame exists at the rear of the rear burner. The rate at which air enters the firebox is indirectly controlled by regulation of the oven and pipe dampers.

Stove-pipe temperatures were higher during operation of this steel stove than was true of the more expensive cast-iron cookstove. Also, the oven damper of the steel range did not have as great an effect on oven temperature as was obtained with the oven damper of the cast-iron stove. Oven temperatures in the steel range oven were decreased only 30° F. when the oven damper was opened; the cast-iron oven was cooled more than 100° F. when the oven damper was opened. An inspection of the construction of the dampers in these two stoves would lead one to believe that poor operation might be expected from the damper in the low-priced stove.

Slightly more time was required to heat water on the steel range than on the cast-iron stove when heating was begun with the lighting of the burners. When the valves were set to maintain a temperature at the middle, horizontal plane of the steel oven comparable to that obtained in the cast-iron oven during maintenance, more time was required to heat water on top of the hot steel stove than on the cast-iron stove. This could be expected because a lower valve setting was required to maintain the middle plane of the steel oven at a temperature similar to that had in the cast-iron oven. As was reported for the cast-iron range, more time was required to heat water on the steel range when the pan was

placed directly over the fire than when it was on the intervening stove lid.

There was no significant difference in rate of kerosene consumption when the two makes of burners in the two stoves were operated on similar valve settings.

Oven temperatures were measured by means of three horizontal planes of thermocouples, five couples in each plane. The middle plane was at equal distance between top and bottom walls; the top plane was at a distance below the top wall equal to 1/8 of the effective height of the oven; and the bottom plane was an equal distance above the bottom wall. In each plane there was a thermocouple in the center and one in each of the four corners; the corner couples were placed at a distance from oven walls equal to 1/8 of effective width and length of the oven. During preheating of the oven and during maintenance of a given baking temperature, the readings of the five thermocouples in the middle plane, taken in parallel instead of individually, were used as the measure of baking temperatures. Analysis of the oven temperatures shows that this procedure may be questionable if the two stoves are to be compared in regard to time of preheating and to stove temperatures existing during the maintenance of a given baking temperature. This is because the middle plane of the steel oven tended to approach the top plane in temperatures maintained, whereas in the cast-iron oven the middle plane tended to approach the bottom level in temperatures maintained. The middle plane of the steel oven was only 20° F. cooler than the top plane, but in the cast-iron oven the middle plane was 40° F. cooler than the top plane. The bottom plane of the steel oven was from 30° to 50° cooler than the middle plane; the bottom plane of the cast-iron oven was only 20° to 30° cooler than the middle plane.

The middle plane of the steel oven was heated to 400° F. or to lower temperatures in only slightly less time than was true of the cast-iron oven, but to temperatures above 400° in considerably less time. A lower valve setting was required to maintain the middle plane of the steel oven at a given baking temperature than was needed for the cast-iron oven. Baking tests have not been made to ascertain whether better performance is obtained on a rack at the middle level or on the floor of the oven.

In both ovens, the oven-door temperature indicator gave read-

ings of the temperature at the back of the indicator. The home-maker is interested in temperatures at the baking areas. Apparently, these indicators have not been calibrated to indicate temperatures at the baking areas.

Practical applications which are of interest to the home-maker are: The oven receives heat more slowly, and probably insufficiently, when the burners are set high in the firebox. According to the temperature distribution noted in these two ovens, considerable adjustment will be necessary to find in each make of stove suitable temperatures and areas for baking of batters and doughs. During the testing of the low-priced stove, several features of inconvenience and of poor construction were noted. The features of inconvenience were: the necessity of opening a drawer to gain access to the valves for regulating the flames; the force required to turn the valves; and the top of the stove too small for the placing of wide utensils side by side. Constructional features which may be objectionable were: the lack of an air vent in the fuel pipe; the inadequate regulation of drafts; the design of the burner bowls such that it is difficult to keep them level; and the use of material in the burner sleeves which warps readily.

FARM CREDIT

Farm Credit in Maine. Charles H. Merchant. A study of agricultural credit conditions in Aroostook County is nearly completed. The information for this study has been obtained from farmers, tax officials, and credit organizations. The material deals directly with the financial conditions of farmers and local governments. Prices received for potatoes have a direct effect on financial conditions of farmers and the relative prosperity of the entire community.

FIELD CROPS

Field Corn Variety Trials. Russell M. Bailey. The work of testing new field corn varieties and hybrids was continued in 1939 with the addition of new material from several sources. In addition to the trial at Highmoor Farm, a cooperative test on some of the most promising material was conducted at New Sharon,

Maine. The results of this trial were in excellent agreement with previous performance at Highmoor Farm. The varieties were planted in four randomized blocks with each plot consisting of four rows forty feet in length. The following table presents a summary of the performance in the New Sharon trial:

TABLE 12

Variety	Yield air dry corn per acre	Dry matter in 10 ear sample	Shelling	Kernel color
	bushels	per cent	per cent	
FLINTS				
Fitch Flint	28.9*	67	83.2	Deep yellow
Nelson Flint	38.5	59	83.0	Deep yellow
DENTS				
Minn. 13 (Haney strain-lot 1)	41.1	58	80.0	Yellow
Minn. 13 (lot 2)	42.1	59	82.5	Yellow
Minhybrid 402	51.5	56	83.0	Yellow and white
WISCONSIN EXPERIMENTAL FLINT-DENT HYBRIDS				
(BB85x549) (Dx9)	57.6	62	83.0	Yellow
(BB17x542) (Dx9)	57.0	62	82.2	Yellow
(BB85xC14) (Dx9)	48.9	62	83.2	Yellow

* Yield probably reduced because of incomplete stand.

In the above table it may be observed that the three Wisconsin flint-dent hybrids were early maturing and outstanding in yield.

In 1939, at Highmoor Farm also, the performance of the flint-dent hybrids was outstanding. The average yield of the three was 53 per cent above the average of six flint varieties. Dry matter data indicated that the flint-dent hybrids were as early maturing as the average of the six flints under trial. These hybrids were superior also to the flints in stalk strength, vigor, and ear height. Unfortunately, however, seed is not available for them commercially but work is in progress to produce flint-dent hybridized seed for more extensive cooperative trials with farmers and to study the possibilities of producing such seed in Maine.

Of the commercially available material, Minhybrid 402 and Minnesota 13 (Haney strain) dents, although slightly later maturing than Maine flint strains, appear to be sufficiently early to be worthy of trial by farmers in central and southern Maine. At High-

moor Farm both have yielded considerable more than the flints and the strong stalks and strong ear shank permit leaving the ears on the plant late in the fall. Minnesota 13 is superior to Minhybrid 402 in feeding value because of higher carotene content and is slightly earlier in maturing the crop.

For ensilage, Cornell 29-3 has given excellent results in several cooperative trials with farmers and is highly recommended for this purpose.

Small Grain Variety Test. Joseph A. Chucka and Arthur Hawkins. *Oats.* Ten varieties of oats (Erban, Vanguard #7, Maine 340, Eagle, Sovereign, Gopher, Victory, Lenroc, Minnesota Smut Resistant, and Upright) were included in the oat variety test at Aroostook Farm in 1939. The above varieties are listed in the order of their yields (highest to lowest). Two of the varieties, Erban and Vanguard #7, produced somewhat higher yields than Maine 340 and show considerable promise for Aroostook conditions. Of the five varieties that produced a higher yield than Gopher, Eagle and Sovereign are later maturing and are both rather susceptible to stem rust.

Wheat. Ten varieties of spring wheat (Premier, Rival, Mercury, Canadian R. L. 1005, Apex, Sturgeon, Reward, Garnet, Thatcher, and Sartov) were included in the wheat variety test at Aroostook Farm in 1939. The varieties are listed in the order of their yields (highest to lowest). Seven varieties produced higher yields than Garnet. Of these seven the first three listed appear to show considerable promise for Aroostook conditions.

Barley. Six varieties of barley (Byng, Hannchen, Alpha, Velvet, Wisconsin 38, and Oderbrucker) were included in the barley variety test at Aroostook Farm in 1939. The varieties are listed in the order of their yields (highest to lowest). Of these Byng, Velvet, and Wisconsin 38 are smooth awned and the other three varieties have barbed awns.

FOODS AND NUTRITION

A Study of the Food Habits and Nutritional Status of Children in Selected Communities in Maine. Mary M. Clayton. The long-time study of the children in the Newport grade-school, begun in the fall of 1936, was ended this spring

(1940). Last fall (1939) all of the children received physical examinations by Dr. Walter L. H. Hall, of Old Town, and, as in previous years, examinations of the teeth were made by Miss Dorothy Bryant, Associate Director of Dental Health for the State Department of Health. As in 1938-39, examinations of the mucous membranes of the mouth were made both fall and spring by Dr. Philip W. Woods, State Director of Dental Health. Measurements of the children were again made both fall and spring according to the system developed at the University of Iowa by Dr. C. H. McCloy. A partial analysis of the measurements indicated that since last year there had been a slight decrease, both fall and spring, in the percentage of underweight children. Last fall the percentage of children who showed a relative lack of normal fat was about the same as in the fall of 1938 but this spring the percentage was lower than in the previous spring. This year there was a decrease also in the percentage of children who showed a relative underdevelopment of the muscles as indicated by limb girth measurements. The condition of the teeth of the children seemed to be very much the same this year as last. In the fall the percentage of the children with inflamed gums was lower than in the fall of 1938 but this spring the percentage had increased to almost what it was last spring (1939). This spring diet records for one week were secured from all of the children above the third grade but these have not yet been analyzed.

A complete analysis of the data secured in Mars Hill in 1936-37 and in Newport between the years 1936 and 1940 will be made this winter. Special study will be made of the growth of the children as compared with that of children of the same ages in the University of Iowa Elementary School and in schools from other parts of the country. An attempt will be made to discover any demonstrable relationships between the growth and physical condition of the children and their diets. The possible effect of health education and changing economic conditions will be considered.

THE RELATION OF THE DIETARY HABITS AND FOOD RESOURCES OF MAINE PEOPLE TO THEIR STATE OF NUTRITION WITH RESPECT TO VITAMIN C. Mary M. Clayton. *a. The Availability for Human Nutrition of the Vitamin C in Potatoes.* The method which was developed last year for the study of the availability for human nutrition of the vitamin C in foods was applied this year to a study of the potato. Four University of Maine students, three boys and

one girl, were used as subjects. Results of the experiment have already been published[2] but it can be briefly stated that by a method involving the use of a potentially neutral basal diet, together with blood and urine analyses, it has been shown that in November three medium-sized baked potatoes of the Green Mountain variety can supply two-thirds of the optimum daily requirement of vitamin C for a normal adult. In the application of the results of the experiment, it should be recalled that potatoes show varietal differences in their vitamin C content and that the amount in them varies according to the time in storage and the method of cooking used. During the coming year other foods, such as raw cabbage, will be tested by the same method.

b. The Effect of Sodium Chloride and Vinegars on the Oxidation of Ascorbic Acid (Vitamin C). In the report of progress for the year ending June 30, 1936,[3] it was mentioned that some preliminary experiments had been made in an attempt to explain the loss of ascorbic acid in pickle making. In these experiments pure ascorbic acid, sodium chloride, and cider vinegar were used. Since then a series of additional experiments[4] have been performed in order to determine the following:

1. What is the effect of sodium chloride alone upon the rate of oxidation of ascorbic acid?

2. Does the effect of sodium chloride vary according to the type of solution of ascorbic acid?

3. Is there any difference in the effect of 5 per cent acetic acid and cider, malt, and white vinegars (containing 5 per cent acetic acid) upon the rate of oxidation of ascorbic acid?

4. What effect does vinegar, as used in mayonnaise and French dressings, have upon the rate of oxidation of the ascorbic acid in raw cabbage?

The results of experiments performed in attempts to answer questions 1 and 2 are given in Table 13. It will be seen that in a solution of pure ascorbic acid in glass-distilled water the presence of 6 per cent of sodium chloride greatly retarded the oxidation of

[2] A method for the study of the availability for human nutrition of the vitamin C in foods, with an application to the study of the potato. Mary M. Clayton and Marie T. Folsom. J. of Home Ec.,Vol. 32, pp. 390-395, June, 1940.

[3] Maine Agr. Exp. Sta. Bul. No. 384, p. 400.

[4] The experiments here reported were performed by Marie T. Folsom.

TABLE 13

Effect of Sodium Chloride upon the Percentage Loss of Ascorbic Acid from Solutions of Pure Ascorbic Acid, Raw Green Pepper, and Cooked Green Pepper*

	Date 1940	Solvents used to make stock solution	Diluting fluid†					
			Glass distilled water	Glass distilled water plus 6 per cent sodium chloride	Ordinary‡ distilled water	Ordinary distilled water plus 6 per cent sodium chloride	Tap water	Tap water plus 6 per cent sodium chloride
			% lost	% lost	% lost	% lost	% lost	% lost
Pure ascorbic acid. 50 mg. in 50 cc. solvent	3/21	Glass distilled water	90.4	5.3	87.7	6.4	100.0	64.3
	3/25	8 per cent acetic acid			31.8	3.6	81.0	32.3
	3/22	8 per cent acetic acid plus 2 per cent metaphosphoric acid	2.1	16.5	2.1	15.0	2.1	62.9
Raw green pepper. 30 gms. in 50 cc. solvent	3/25	Ordinary distilled water			76.7	43.0	97.8	97.6
Cooked green pepper, boiled 6 minutes 30 gms. in 50 cc. solvent	3/28	Ordinary distilled water			69.2	39.2	99.3	9.93

* After standing over night at room temperature. Indophenol titration method of analysis used.
† 5 or 10 cc. of stock solution were added to 45 or 40 cc. of diluting fluid.
‡ Copper still with block tin lining.

ascorbic acid. The sodium chloride was almost equally effective in ordinary distilled water but in tap water it was much less effective. When the stock solution of ascorbic acid contained acetic acid, oxidation with and without sodium chloride was retarded more than when it contained only water. When the stock solution also contained metaphosphoric acid, oxidation was greatly retarded without sodium chloride but with sodium chloride it was accelerated.

In ordinary distilled water solutions of both raw and cooked green pepper, the sodium chloride had a retarding effect upon the rate of oxidation of ascorbic acid. The effect was not as great, however, as in ordinary distilled water solutions of pure ascorbic acid. In tap water solutions of both raw and cooked green pepper, the sodium chloride did not show any retarding effect after 24 hours, although such an effect might have been shown had the time interval been shorter. Thus, in pickle making, soaking the vegetables in brine over night would at least have no accelerating effect on the oxidation of ascorbic acid present, although the vegetable juices containing ascorbic acid would be partly drawn out into the brine, which is discarded.

TABLE 14

Effect of Vinegars upon the Rate of Loss of Ascorbic Acid from an 8 Per Cent Acetic Acid Extract of Raw Green Pepper (2-26-1940)*

Time from first titration	5 per cent acetic acid 40 cc. plus 10 cc. extract		White vinegar 40 cc. plus 10 cc. extract		Cider vinegar 40 cc. plus 10 cc. extract		Malt vinegar 40 cc. plus 10 cc. extract	
Hours	Mg. ascorbic acid per 50 cc.	% lost	Mg. ascorbic acid per 50 cc.	% lost	Mg. ascorbic acid per 50 cc.	% lost	Mg. ascorbic acid per 50 cc.	% lost
0	2.72		2.71		2.55		2.40	
2.5	2.52	7.4	2.06	24.0	1.23	51.8	1.54	35.8
4	2.37	12.9	1.72	36.5	.95	62.8	1.17	51.3
24	.66	75.7	0.00	100.0	0.00	100.0	.11	95.4

* 50 gms. pepper in 100 cc. 8 per cent acetic acid.

Table 14 summarizes data from an experiment planned to answer question 3. It will be seen that after intervals of 2½ and 4 hours a difference was shown in the effect of the 5 per cent acetic

acid and the different vinegars on the rate of oxidation of the ascorbic acid in raw green pepper. Oxidation was much less in the acetic acid solution than in the solutions of the vinegars. Of the three vinegars, cider caused the greatest percentage loss and white the least. After 24 hours no significant difference was shown between the three vinegars, since the loss was practically complete, but the percentage loss with acetic acid was still less than 100. The difference between the effect of the acetic acid and the vinegars cannot be explained at this time.

Tables 15 and 16 give summaries of experiments performed to partly answer question 4. It will be seen in Table 15 that when raw cabbage was mixed with mayonnaise made with cider vinegar and with that containing distilled water, as a control, the rate of loss was much higher with the vinegar mayonnaise. It was thought that possibly mayonnaise made with lemon juice might cause a lower rate of oxidation than that made with vinegar, but, as shown in Table 16, the difference between the two was not very great. The lemon juice mayonnaise used in this experiment had been made four days and contained no ascorbic acid. A preliminary experiment using raw cabbage and French dressings made with vinegar and lemon juice showed that the rate of loss with the two kinds of dressing was about the same, although that with the vinegar dressing was slightly greater.

TABLE 15

Effect of Mayonnaise Containing Cider Vinegar upon the Rate of Loss of Ascorbic Acid from Raw Cabbage (6-6-1940).

Time from first analysis	Vinegar mayonnaise 15 gms. to 50 gms. cabbage		Distilled water mayonnaise 15 gms. to 50 gms. cabbage (control)	
Hours	Mg. ascorbic acid 10 gms. cabbage	% lost	Mg. ascorbic acid 10 gms. cabbage	% lost
0	1.390		1.620	
3	.574	58.7	1.446	10.7
5	.280	79.9	1.333	17.7
24	.000	100.0	.500	69.1

TABLE 16

Comparison of the Effect of Mayonnaise Made with Cider Vinegar with Mayonnaise Containing Lemon Juice upon the Rate of Loss of Ascorbic Acid from Raw Cabbage (6-14-1940)

Time from first analysis	Vinegar mayonnaise 15 gms. to 50 gms. cabbage		Lemon juice mayonnaise (four days old) 15 gms. to 50 gms. cabbage	
Hours	Mg. ascorbic acid 10 gms. cabbage	% lost	Mg. ascorbic acid 10 gms. cabbage	% lost
0	.973		.887	
2½	.313	67.8	.380	57.1
4¼	.300	69.2	.373	57.9

From the above experiments it would appear that in order to obtain the maximum amount of vitamin C from foods, vinegar or salad dressings should not be allowed to come in contact with them for any length of time before they are eaten. The low vitamin C content of pickles can be explained as due to the loss of vitamin C by solution and by oxidation, which is accelerated by the vinegars used.

THE RELATON OF MAN AND OF ANIMALS TO THE ENVIRONMENT. V. W. Franklin Dove. *(a) Extra-nutritional Determiners of Malnutrition.* Nutritional well-being in both man and animal depends upon a large number of modifying conditions—conditions which extend far beyond the circumscribed researches covered by the specialized science of nutrition, and reach into more fields of human endeavor than is usually recognized. The elimination of malnutrition, therefore, rests not alone on the basis of research on the nutritive values of foods as such but depends equally, at times predominantly, upon the attitudes of others in fields completely dissociated from the science of nutrition.

In order, then, to "solve" the problem of nutrition it has been necessary to devise experiments and techniques which include under one program all potential extra-nutritional or indirect determiners of malnutrition together with suspected direct causative agents residing or lacking in the foods themselves. Such a program has been made possible through the reorientation of projects to form a so-called linkage of climate-soil-plant-animal-man with food production analyzed in terms of physiological need, that is in terms

first of production for use to precede the heretofore dominant terms of production for markets (or exchange). In brief, and in order to distinguish these two kinds of foods, we have called foods produced under this linkage program *aggridant foods,* since they supply the needs for physiological efficiency of the consumer in a specified environment and are different frequently from the foods produced regionally for the markets of the Nation: Aggridant foods supply nutrients for regional needs, while foods for the market frequently supply both industry and the consumer in localities far removed from the point of origin of the food and in regions where even the physiological needs of the consumer are different from those in the region where the foods were produced. In these important respects, then, aggridant foods differ from foods now being produced for the market. Furthermore, these experiments on the production of aggridant foods represent the first coordinated attempt to adjust food production to the physiological needs of the consumers within any particular region.

For good nutrition of populations, the nature of the dominant deficiency may be any one or more of a hundred or more possible types. But the first major problem in the nutrition of populations is to discover and properly rate deficiencies in their order of importance to the group at large.

Experiments carried on to date on the determination of regional needs and on the production of aggridant foods to meet those needs, have been directed toward calcium, phosphorus, and vitamin D,[5] vitamin C,[6] vitamin B,[7] vitamin E,[7] the effect of production for the market in contrast to production for use to precede production for the market,[6,8,9] and to Specialization-Diversification patterns or production.[9,10] Several of these studies have had to do with foods themselves, while other phases of the work, especially the two latter, implicated extra-nutritional causes. In furtherance of both phases of the study and in order to carry on an experimental analysis of the linkage, special soil fertility plots have been built up, new and adaptable crops are being selected, and appropriate experi-

[5] Me. Agr. Exp. Sta. Bul. 375, pp. 191-284, 1934.
[6] Science 83: 325-327, 1936.
[7] Jour. Hered. 30: 157-163, 1939.
[8] Me. Agr. Exp. Sta. Bul. 380, pp. 187-204, 1935.
[9] Me. Agr. Exp. Sta. Bul. 397, pp. 726-729, 1939.
[10] Me. Agr. Exp. Sta. Bul. 397, pp. 738-749, 1939.

mental food-getting techniques have been devised.[11] For the soil problems, in 1930 land was acquired that had been depleted of its fertility by continuous cropping for the preceding 18 years. During that 18 years no fertilizers had been added to the land. This piece of depleted land was then divided into several parts of approximately one acre per plot. One part (Field B) was continued on a depleting-system of cropping, while the other four parts were built up in fertility by different methods.

An attempt was made to bring Field A (one of the replenished plots) up to the highest stage of fertility by rotation of crops, by plowing under various green manure crops, and by additions of complete commercial fertilizers. The attempt to bring back fertility to Field A by green manure and by rotation of crops with clover soon proved futile. Even after several years of heavy applications of commercial fertilizers the level of available nutrients elements, though raised above the depleted Field B, has not as yet been raised to an optimum level. During this time and up to 1939 inclusive, the amount of commercial fertilizer alone added to this plot totaled 2,700 pounds of 20 per cent superphosphate, 950 pounds of 50 per cent muriate of potash, 750 pounds sodium nitrate, and 4,500 pounds of dolomitic limestone. The effect upon the mineral content of the crops grown thereon has been positive. By the summer of 1939 buckwheat grown on both Fields A and B had already produced grain differing considerably in mineral content. The differences in mineral content and the general appearance of differences in rate and type of growth of crops on these two soils of divergent fertility treatment, warrant an extensive trial of regional food crops for varietal adaptability and for use in nutrition experiments. For this purpose, in the spring of 1940, eight to sixteen varieties of most of the leading food crops of the State have been planted upon these two Fields A and B. (See Figure 5.)

The Mineral Content of Buckwheat Grown at Orono, Maine, 1939, on Depleted and on Replenished Soil[12]

	Calcium	Phosphorus	Potassium
(1) On Soil-Depleted Field B	.105%	.23%	.43%
(2) On Soil-Improved Field A	.160%	.27%	.50%

[11] Amer. Nat. 69: 469-544, 1935.

[12] Mineral analyses were made by Mr. Bernie E. Plummer, Jr., Department of Chemistry, Maine Agr. Exp. Sta.

Aside from the depletion of minerals in the crops grown on the depleted plot, preliminary trials indicate that there is also a difference in the acceptance value of the food produced thereon when presented to experimental animals. Individual consumers may be able to adjust their food-getting to the effects of low nutrient levels in *one* of their foods but when several or *all* foods are secured from crops grown on infertile soil, the effect upon the individual may or may not be disastrous. The nature of these changes in soil and their effect, ultimately, upon the consumer will be left for future consideration.

During the course of these experiments there was observed to exist among the experimental animals, a high preference rate for buckwheat grain. Furthermore, buckwheat was found to supply so many of the nutrient values of the diet that it could, at times, effectively replace high-vitamin A foods like yellow corn and high-vitamin B and E foods like wheat or oats. Buckwheat grows well in the short, cool seasons of northern Maine in a latitude up to 47° 30′, and north of the best growing range for high-vitamin A-foods like yellow corn. Buckwheat, as a free self- and cross-pollinating crop is also comparatively resistant to diseases and free from pests and will produce a crop almost anywhere in the cool climate of Maine and northern New England. In Maine, buckwheat has been used since the days of earliest settlers as the staple cereal or flour food especially by the inhabitants of the St. John River Valley.

The foregoing list of characteristics of buckwheat indicate that it may be classified as an aggridant food crop—after a few readjustments have been made to preclude the occurrence of Fagopyrism and to ensure by genetic means an optimum nutritional pattern. Consequently a large number of varieties of buckwheat have been secured from several parts of the world in order to secure strains best adapted to the region and highest in nutrient value. From 14 varieties grown in the summer of 1939, several varieties have been found which are high in Beta-carotene and are adaptable to the region. (Table 17.) Some varieties of buckwheat contain 6 times the amount of Beta-carotene contained by other varieties, but fortunately for buckwheat, it has not heretofore been of sufficient commercial interest to have attracted selection for whiteness as has flour wheat. Consequently, there is much more Beta-

carotene in most of the buckwheat varieties than can be discovered in flour wheat varieties. Although some varieties are lower than others in Beta-carotene, buckwheat varieties are usually superior to wheat, rye, barley, and oats in this respect and therefore, with its additional high preference value, for experimental animals, buckwheat stands far ahead of other cereal grains of the region as a potential source of nutrients.

At the present time sufficient buckwheat is grown by the inhabitants of the St. John Valley to supply their own uses: buckwheat flour for the family, buckwheat bran for the livestock, and buckwheat hulls for insulation in buildings and for use as packing material. Whether or no the native buckwheat is of the best variety, whether it should be grown on the infertile areas even though it grows fairly well on infertile areas, whether it should be deprived of its bran by local millers as it is at present remains for experiments in progress to disclose.

(b) The Need for Vitamin A Foods and Food Crops and the Genetic Selection for Varietal Differences in Carotene Content. When experiments on the nutritional status of northern New England were first started in this department in 1927, the apriori conclusion was drawn that vitamin A would probably not be of first importance in the series of possible deficiencies.[13,14] While this conclusion still remains true, nevertheless, with methods now being applied to correct deficiencies in calcium (Figure 4) which in 1933-35 was conceded as a major deficiency,[13] in phosphorus, vitamin D and vitamin C, there appears to be a relative rise in importance of vitamin A, so far largely neglected.

Some increase in vitamin A supply in the State has been brought about secondarily by the aforementioned attention given to the correction of other deficiencies. Thus the increased use of lime has obviously increased the production of clover and legumes in the State and this in turn implies more vitamin A. The increased use of both lime and fertilizer on pasturelands through the stimulus of the Experiment Station research, the Soil Conservation Service, and the Extension Service campaigns, has also, during the last few years, increased the ratio of clover to grasses and to weeds.

[13] Me. Agr. Exp. Sta. Bul. 369, p. 528, 1933; Me. Agr. Exp. Sta. Bul. 375, 1934.

[14] Me. Agr. Exp. Sta. Bul. 380, p. 192, 1935.

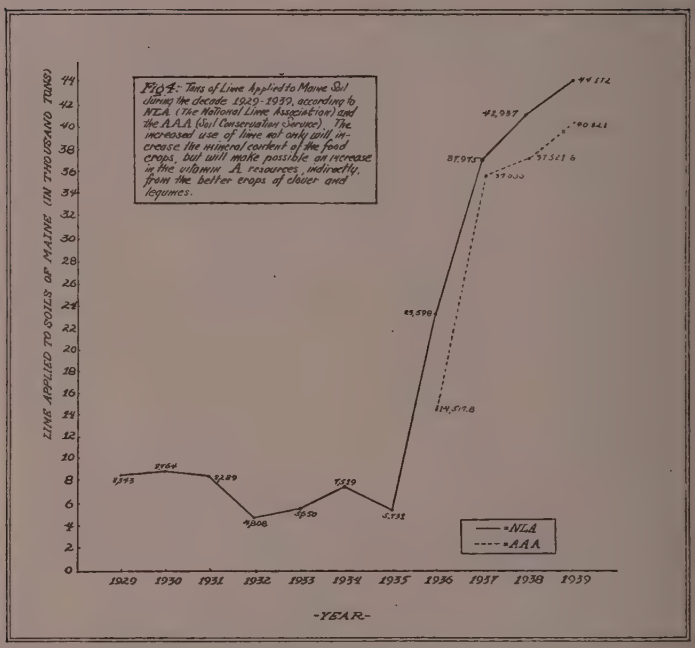
FIG 4:- Tons of Lime Applied to Maine Soil during the decade 1929-1939, according to NLA (The National Lime Association) and the AAA (Agricultural Adjustment Administration) Service. The increased use of lime not only will increase the mineral content of the food crops, but will make possible an increase in the vitamin A resources, indirectly, from the better crops of clover and legumes.
LIME APPLIED TO SOILS OF MAINE (IN THOUSAND TONS)
-YEAR-
1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44
8,343
9,164
8,289
4,806
5,550
7,519
5,732
23,598
124,517.8
37,975
42,987
44,172
90,842
57,521.6
57,000
=NLA
----=AAA

FIG. 4. Lime applied to soils of Maine, 1929-1939.

From the increased clover production alone much larger supplies of vitamin A, than were produced five years ago, must now be available for livestock and, in turn, for the production of a better by-product of milk, eggs, and meat destined finally for the human consumer. Furthermore, in addition to the research and extension work carried on within the State an increase in vitamin A and vitamin C resources is to be noted also as the result of diversified plans extended over the State through the Farm Security Administration and the U. S. government loaning agencies as requirements for their clients. A more diversified agriculture and a larger use of home gardens have been the immediate results of these action groups; the increased use of home gardens especially may have contributed much to the increase of vitamin A. Nevertheless, and in spite of all of these aids to a higher vitamin level for the population, the requirements for vitamin A are so high and the adjust-

ments which might be or should be made exceed the small changes already made so markedly, that vitamin A nutrition continues to be an ever more important factor in the nutritional welfare of the inhabitants of the region.

Preliminary evidence for the existence of vitamin A deficiencies in the region has already been reported.[15,16] This circumstantial form of evidence, while helpful in the planning of corrective methods and in drawing attention and funds to make possible more detailed studies, does not bring the evidence down to the individual factual level. Such individual factual evidence has also had to await the availability of equipment suitable to mass population studies.

Among various instruments devised for the rapid classification of large populations, the Pett Vitometer has now been used by the writer with apparent success in the test for visual adaptation in terms of visual recovery time, a reaction known to be associated with vitamin A status.[17,18]

Discussion has been given to the possible increase in vitamin A resources of northern New England during the past five years over the amount available prior to that time as the result from increases in the production of clover and improved grasses, from the increased use of home gardens, and as the result of diversification. The point must be made, however, that not all of these changes ensure a mass increase in vitamin A supply: that some of the changes may be associated with an actual decrease in total vitamin A made available. This regressive effect of improved methods is brought about chiefly through a neglect of the *qualitative* factor in the foodgetting pattern. Experiments have been reported[19] which show that the simple exchange of one variety of food for another (yellow for white corn) is disastrous to the existence of the consumer, and may be lethal. Varieties of foods selected for whiteness—of which there are many—decrease the efficiency in

[15] Me. Agr. Exp. Sta. Bul. 375, p. 205, 1934.

[16] Me. Agr. Exp. Sta. Bul. 380, p. 192, 1935.

[17] J. Biol. Chem. 132: 2: 585-593, 1940.

[18] Since the end of the fiscal year for this report, results of tests in September, 1940, on 378 University of Maine college students show that 79 individuals, or 21 per cent, were low in vitamin A when judged by a visual recovery time of 11 seconds or longer.

[19] Me. Agr. Exp. Sta. Bul. 397, p. 760, 1939.

the use of the food in proportion to the decrease in vitamin A. This decrease in efficiency in the use of food may be widespread and serious among the members of a population before any other sign of vitamin A deficiency appears. This widespread inefficiency is perhaps more common to consumer groups like man and wild life who secure their food by a "free-selection" method. The partial freedom in the selection of food may give to such consumer groups the opportunity to adjust themselves partially and escape the exaggerated signs of the deficiency, but for lack of access to a generous supply, they may fail to rise above a mediocre level of physical status.

The increased dependence upon home-grown foods increases the use of food crops frequently low in Beta-carotene. The possibility of using white varieties of food crops increases in this particular northern region where not only has the chief crop, potatoes, been selected, unwittingly, for low carotene content, but early maturing crops—a necessity in this region—frequently are those, like Sanford White, Early White Aroostook, White Sweet Fodder, Assiniboine, and some strains of Northwestern Dent Corn, known to be low in this essential food factor. For these reasons, the mere physical basis for diversification is precluded; for example, the simple return to increased beef production in the region will depend first upon recognition of the *qualitative* factor of the aggridant food pattern.

Recognition of the importance of the qualitative characteristic of aggridant foods has prompted and stimulated the search for food crops of the region, actual and potential, high in Beta-carotene and other vitamin A precursors. The search for vitamin A foods is, however, conditioned by consideration for the characteristics of an aggridant food as previously defined and as explained here as follows:

An aggridant food crop by definition implies the existence in the food crop of more than one nutrient of important use-value. However, in the production of new combinations of nutrients in adaptable varieties by genetic methods, a pattern of nutrient combinations must be recognized before any logical and systematic method of improvement is ensured. One important consideration to be recognized in the production of aggridant food crops replicates in many respects the patterns of different foods required for the production of aggridant individuals. These food-getting pat-

terns of aggridant individuals have specific characteristics which, if recognized and followed, ensure the transference of the aggridant type to succeeding individuals fed according to this pattern of the aggridant.

One of the six characteristics of food-getting patterns[20] of aggridant individuals has been shown to consist in the recurrence of a so-called Specialization-Diversification Pattern of food-getting in which no single food could monopolize the pattern and yet in which some one food usually dominates the series in preference value.

If, then, an aggridant food is to be synthesized in accordance with these implications, each food will be made up as patterns of different nutrients in place of patterns of different foods. Similarly, as the aggridant patterns of different foods show definite Specialization-Diversification ratios between different foods while one food may dominate, yet no single food monopolizes the pattern, so with a single aggridant food, one nutrient may dominate but never monopolize the pattern of nutrients. According to this qualitative characteristic of food-getting, an aggridant food when broken down into its parts (nutrients) may show many diverse patterns, each according to its dominant use-value for the consumer involved.

These theoretical implications may be broken down to examples as follows: aggridant sweet corn may show a pattern dominated by vitamin A, with a second facet vitamin C, and a third facet some one of the amino acids, viz., ACZ+. On the other hand, in the same region an aggridant variety of cabbage may be expressed in patterns as CACa+, while bean varieties might be secured in terms of vitamin B, lysine, fats, and potassium +.

With this approach to modifying the food crops of a region in accordance with the pattern of needs, an attempt has been made to classify some of the important plant-foods of the region for Beta-carotene in search for those food crops in which vitamin A may be the dominant nutrient (or may have potentialities for dominance). In Table 17 data on the range of Beta-carotene content of 232 varieties of 12 food crops are presented.

The interpretation of results for our present purposes are as follows: (1) Some varieties of potatoes, sweet corn, field corn, peas, and buckwheat are excellent sources of vitamin A. Never-

[20] Me. Agr. Exp. Sta. Bul. 397, pp. 740-743, 1939.

TABLE 17

*Varietal Differences in the Beta-Carotene Content of Some Important Maine Food Crops**
1939

Beta-carotene as per cent dry weight (10^{-4})	Potatoes	Sweet corn	Field corn	Peas (green seeds)	Peas (white seeds)	Buckwheat	Millet	Oats	Barley	Wheat	Rye	Beans	
4.65	1												
1.9			1										
1.8													
1.7													
1.6			1										
1.5													
1.4		1	1										
1.3			3										
1.2	1	1	2										
1.1		3	2										
1.0		2	4										
.9		5	3										
.8		5	8										
.7		—	8										
.6		3	13	4		2							
.5		1	4	5	1	1	1						
.4		—	4	1	5	4							
.3		—	3	1	3	6	1	1					
.2		2	1		2	1		5	6	1			
.1	2	—	3			2	1	11	9	12	2		
.09								4	1			1	
.08		1							3	3			
.07		2						1		3	1		
.06		1						4		4			
.05		1						1		3	1		
.04								1	1	1		1	
.03			1					1		1		2	
.02		1										2	
.01												9	
N=	4	29	62	11	11	16	3	29	20	28	4	15	=232

* The writer is indebted to Dr. Elmer S. Miller, Department of Botany, University of Minnesota, for the spectrochemical determinations.

theless, some varieties of each of these food crops as now produced on the basis of market requirements cannot supply significant quantities of this vitamin for the support of normal existence in the consumer. (2) Some of the principal food crops like white potatoes, sweet corn, field corn, wheat, and beans are very low in this important nutrient and, since these are important foods in the diet of the people, the difference between malnutrition and abundant

health may, in unnumbered instances, depend upon these slight but accumulative gene-nutrient differences. In this one respect alone, genetic improvement could make an important contribution toward the elimination of malnutrition within the region, and the plant breeder, then, like the market economist, represents another group of non-nutritionists whose plans at times determine the nutritional status of a population.

(c) Requirements for the Production of Aggridant Foods. In accordance with the production of aggridant individuals, aggridant foods are produced only when the same use-value is applied to all sciences concerned with food production. Thus foods may be considered aggridant foods ONLY when they are produced under conditions in which the soil type, the fertility level, the genetic balance of nutrients in the crops or food, and the method of production, harvesting, marketing, and preparation have been carried on for the establishment of the optimum nutritional status of the consumer.

According to the foregoing requirements in the production of an aggridant food crop or food, certain types of research on foods are implied as of more importance than others in solving the problems of malnutrition. Since many of these phases of the problem of malnutrition reach out into branches of research not generally concerned with nutrition per se, their inclusion in a nutritional program will require a reorientation in part of present lines of research and a cooperative and integrated approach. Before describing some of the separate phases of this research and in order to show the relation of the parts to the whole, the important or key phases of research necessary for the production of aggridant foods will be listed briefly as follows:

1. For the production of aggridant food crops and foods, research is implied in terms of values based upon production for use *to precede* values based upon production for the market.

2. Soil surveys are required in terms of the level of nutrients available for the production of aggridant food crops in addition to and simultaneous with the present classifications based upon soil type, class, profile, and yielding ability.

3. Fertilization of soils, rotation of crops, and management practices must be judged in terms of their effect upon the nutrient values of foods and these nutrient values must *precede* values based upon quantity production, for the market only. (Figure 5.)

FIG. 5. The effect of soil fertility on the nutritive value of food crops.

Chiefton, a Savoy variety of cabbage, represents one among a large number of varieties of food-crops grown on two Fields (A and B) known to be high and low in available mineral content. (See text page 237 for a description of the soil treatment.) Large size is not always associated with high nutritive value. For instance, data by Miss Elizabeth F. Murphy, in press, on the relation between size and ascorbic acid content of onions show that small varieties of onions, as well as small individual onions within a variety are higher in vitamin C content than are the large-sized varieties or the large individual onions within a variety. Furthermore, a growth rate somewhat *below* the maximum has been demonstrated by the writer as the best for certain forms of animal life,* and this same phenomenon may present itself in plant growth. As with animal life, the optimum rate of growth for the particular genotype and environment can be controlled by adjusting the pattern of nutrients to conform to aggridant food needs, so too with plant life, one may predict that the optimum rate of growth may be controlled by an aggridant pattern of soil-fertility. For these reasons, then, the relative value of foods grown on fertile vs. infertile soil should not be judged solely by differences in size or in yield of the crop. The purpose of these particular experiments is to determine an *aggridant* level of soil-fertility, and that is a fertility level designed to produce food of highest total nutritive and preference value rather than of highest yield. In this manner production for use is associated with, but precedes, production for the market and thereby ensures the elimination of one of the causes of malnutrition occurring among large population groups.

* Amer. Nat. 69, 1935.

4. A search must be made for a natural or synthetic balance of nutrients in plant and animal foods based upon importation, return to the wild varieties or to gene-nutrient selections to *precede* selection of foods on the basis of yield, disease resistance, keeping and cooking qualities.

5. Methods of production, harvest, marketing, and preparation should be re-examined in terms of aggridant requirements.

6. Determination of ultimate value in a food should be based not only upon the nutrients contained therein, and as explained under points 1, 3, and 4, but also upon the palatability and acceptance value as judged by aggridant individuals and in accordance with the food-getting patterns characteristic of the aggridant.

7. The necessity exists for a continuous regional record of food-production (and associated phenomena such as weather) in terms of consumer foods in addition to those records secured on the basis of producer goods.

8. A continuous, regional, nutritional-status food-habit survey is implicit in this program as a means of determining the nature and the extent of nutritional deficiency diseases—the correctives of which determine the characteristics to be sought in the new aggridant foods.

9. The necessity exists for a continuous regional natural resource and socio-economic record for the co-analysis of other extra-nutritional determiners of malnutrition.

Any one of the foregoing nine basic approaches to the nutritional health aspects of aggrid ascendance could be and generally are—ineffectively, of course—carried on from the point of view of production for the market alone. However, experiments show that when production for use precedes production for the market the consumer is more liable to be assured the opportunity for optimum nutrition.

The results of experiments show that the purely environmental factor *food* may be manipulated in such a way as to alter radically even those forms and functions ordinarily considered *genetic*. The Biological Laboratory has succeeded, through new technique, in discovering certain neglected but superior, natural foods. This technique consists, in brief, of determining those foods essential to longevity, efficiency, and consistency, from a diet indicated by the free choice of those animals which make the best physiological

use of their foods and verified, by forced feeding in test groups, to furnish the elements essential to superior growth.

There is evidence to indicate that to human nutrition also this type of research can contribute improved foods which will bring to human beings in any given environment a fuller measure of health, longevity, and efficiency than is achieved under the present system of food-production. It is possible to derive principles for human feeding from experiments on animals by the device of offering to animals in the laboratory native foods which contain those elements which will satisfy human nutritional defects in this region. To insure the adaptability of such experiments:

(1) A constant study has been maintained of nutritional defects in the region;

(2) An active search has been made for varieties of fruits and vegetables selected primarily for their value in supplying nutritional needs—as opposed to varieties selected for some characteristic extraneous to this purpose.

This threefold method of laboratory experiment, biological survey, and genetic analysis is yielding valuable results in indicating principles and patterns of human food-consumption and consequently food-production. To follow this method, however, it has been found necessary to reorient food production and food research in terms of physiological need, thereby altering the current habit of looking at food-production solely in terms of profit, and also encouraging integration rather than compartmentalization of those sciences which are concerned with food-getting. Such a program demands recognition of the vital linkage between the sciences of soil, plant, animal, and man—since a warping of any chain in the link is bound to react on the end-result—*superior* food for potentially *superior* human beings.

FORAGE CROPS

ALFALFA STRAIN TRIALS. Russell M. Bailey and Delmar S. Fink. A study of alfalfa strains from different sources is in progress in order to determine those best adapted to Maine. In a preliminary trial several strains appeared promising and these have been placed in a new nursery in Latin square arrangement. These comprise Grimm, Norwis, Michigan A68, A69, and A70, Nebraska

A31 and New Jersey A65. Thus far, Michigan A69 has surpassed the others in yield of green weight. Nebraska A31 does not appear adapted to Maine because of winter injury. Grimm has done well in the trial and can be highly recommended for commercial use.

Grassland Studies. Delmar S. Fink and Frank Chadwick, Jr. The Highmoor Farm pasture experiments will include two additional paddocks available for grazing next season (1941). One paddock consists of a turf of zigzag clover *(Trifolium medium)* in association with pure stands of nine common grasses. A second paddock was seeded down to a mixture of reed canary grass *(Phalaris arundinacea)* and strawberry clover *(Trifolium fragiferum)*.

Grassland investigations have been further enlarged to include work on grass silage. The first study will be to determine the economy of making silage out of Ladino clover which is cut into the silo directly from the field with molasses added as a preservative, versus Ladino clover cut into the silo partially air dry (35 per cent dry matter content) with phosphoric acid added as a preservative.

INSPECTION SERVICE

Inspection Service. Elmer R. Tobey, C. Harry White, Bernie E. Plummer, Jr., Glenn H. Perkins, Millard G. Moore, Edward O. Merrill, C. Byron Sibley, John S. Getchell, and George P. Steinbauer. The Commissioner of Agriculture is the executive of the laws regulating the sale of fertilizers, agricultural seeds, insecticides, fungicides, foods, drugs, and feeding stuffs in Maine. It is the duty of the Director of the Maine Agricultural Experiment Station "to analyze or cause to be analyzed" the samples collected by the Commissioner and to publish the results of the analyses together with the names of the persons from whom the samples were obtained and such additional information as may seem advisable. This information is reported in the Official Inspections published during the year. The State Tax Assessor is the executive of the laws regulating the sale of gasoline and motor lubricants. It is the duty of the Director of the Station "to analyze or cause to be analyzed" the samples collected by the State Tax

Assessor but no provision has been made for the publication of the results of the analyses.

In addition to the inspection service, the department is requested frequently to make analyses of various types of materials for individuals. These unofficial samples include milk, cream, vinegar, miscellaneous substances, and materials suspected to contain poison. The results of the analyses on these samples are not published but are reported to the individuals who submit the samples.

A brief summary of the work of inspection is as follows:

Testing of Dairy Glassware. It is required by law that all Babcock glassware used in Maine by creameries, ice cream factories, or others buying or selling milk or cream on a basis of the butterfat content must be tested for accuracy at the Maine Agricultural Experiment Station. Seven hundred and thirty-eight pieces have been examined and all were found to meet the requirements for accuracy.

Fertilizer Inspection. Four hundred and ninety-six samples of fertilizer materials were collected and analyzed. Three hundred and fifty-eight of these samples are mixed fertilizers containing nitrogen, phosphoric acid, potash, and, in some of the samples, magnesium, borax, and manganese. The samples of mixed fertilizers represent two hundred and sixty different brands. The results of the analyses are reported in Official Inspections 173.

Agricultural Seeds. Fungicides and Insecticides Inspection. One hundred and twenty-nine official samples of seeds and sixty samples of fungicides and insecticides were collected and analyzed. The results of the analyses are reported in Official Inspections 174.

Food and Drug Inspection. The number and variety of samples collected and submitted depend upon the nature of the inspection work carried on by the Division of Inspection, Augusta, Maine, in the enforcement of the food and drug laws. A large amount of this inspection work does not require the collection of samples. A total number of five hundred and ninety-one samples of butter, canned blueberries, carbonated beverages, cider, clams in shell, shucked clams, crabmeat, hamburg, honey, ice cream and ice cream mixes, maple syrup, oil used in packing sardines, oysters, quahaugs in shell, scallops, aromatic spirit of ammonia, diluted hydrochloric acid, spirit of camphor, spirit of peppermint, sweet spirit of nitre, and tincture of iodine have been examined. The results of the analyses are reported in Official Inspections 175.

Bacteriological Work. The amount of work carried on in the bacteriological laboratory has increased approximately one hundred per cent over last year. A total of four thousand three hundred and seventy-four official samples have been examined. Of this number, four thousand and seventy-seven samples were milk and cream; the remaining number includes one hundred and sixty-four samples of sea water and one hundred and thirty-three samples of shellfish. In addition, about two hundred and fifty-five miscellaneous samples have been examined for municipal departments of health and private individuals. The results of the analyses are reported in the food and drug Official Inspections 175.

Feeding Stuffs Inspection. Nine hundred and one samples of feeding stuffs were received and the percentages of protein, fat, and fiber in these samples were determined. The results of the analyses are published in Official Inspections 176.

Gasoline Inspection. Two hundred and fifty-four samples of gasoline were received. The results of the analyses indicate that two of these samples were found to require a higher temperature for complete distillation than the maximum temperature (437° F.) specified in the Maine law regulating the sale of motor gasoline.

Motor Lubricants Inspection. Five of the thirty-six samples of motor oils which were examined failed to meet the specifications for the respective brands asked for by the inspector. One of the five samples was a "used" oil. In practically every instance it appeared to be a case of substitution by the salesman.

LAND UTILIZATION

Land Use Studies in Maine. Andrew E. Watson. A study of land use in 31 towns in Aroostook County, Maine, is completed in manuscript form. The area included in the study extends from the town of Van Buren on the St. John River through central Aroostook to towns in southern Aroostook. The land area has been classified into land classes after considering such factors as soil type, use of land, topography, type of road, public services, and tax delinquency. Three kinds of programs are suggested in connection with handling the problems in the marginal and submarginal land areas. The programs are (1) developing the natural

resources within the areas, (2) relocation of families, and (3) the development of forest or woodlot areas.

SOIL SURVEY. Joseph A. Chucka, Delmar B. Lovejoy, and John R. Arno in cooperation with Kenneth V. Goodman of the Soil Survey Division, Bureau of Plant Industry, and Von S. Day of the Soil Conservation Service, United States Department of Agriculture. Field work for a detail-reconnaissance soil survey has been conducted during the past year in Waldo County. Detailed information was secured relative to soil type, slope, and degree of erosion on the cleared areas whereas the wooded areas were covered by a more general type of survey. It appears now that the field work will be completed in Waldo County by November 1, 1940.

MAINE SOIL TESTING SERVICE. Delmar S. Fink and J. Wilfred Cyr. The soil testing service has recently moved into a new laboratory on the campus. It is now adequately equipped to meet the rapidly growing demand for soil tests as well as to conduct soil chemical research.

POTATOES

GREEN MOUNTAIN SEED PLOTS. Donald Folsom. Tuberline seed maintained on Highmoor Farm, under an aster-cloth cage in 1936 and in the open in 1937, was grown in 1938 on eight farms in seed plots. In addition, five other plots were planted with seed two to four years removed from Highmoor Farm, and one plot with seed grown at Highmoor Farm under cage in 1935 and in the open in 1936 and 1937. The crops from these 14 seed plots were planted separately in 1939 and the vines were then examined for disease content to determine to what extent disease had either spread or decreased in the plots in 1938.

Only one stock was free of leafroll in 1938 and every stock showed more leafroll in 1939 than in 1938 except one (in Aroostook County) the tops of which were pulled on August 18, 1938. There was no yellowtop in any lot either year, at least up to the time in 1939 for tuber-borne symptoms to show. Mosaic was absent from nine stocks in 1938 and appeared in only two of these in 1939 while disappearing from two of the others. This favorable record was as good for Aroostook County and Patten as for out-

side. However, the average mosaic percentage increased from 1938 to 1939 by 8.3-fold in Aroostook and Patten but only 4.8-fold outside these areas. The average leafroll percentage increased from 1938 to 1939 by 5.3-fold in Aroostook and Patten and 6.8-fold outside. In general, as the location of the plot in 1938 was farther from the southwestern corner of the State, the less leafroll ($r = -0.639$, highly significant) and the less mosaic ($r = -0.215$) there were in 1939.

Size of plot in 1938 had no effect on disease content in 1939. Lateness of planting in 1938 increased the mosaic percentage of 1939 somewhat and earliness increased leafroll. The degree of isolation in 1938 had no consistent effect. Tuber-unit planting and size of seed plot in 1938 produced no significant differences.

AN ECONOMIC STUDY OF THE POTATO INDUSTRY IN MAINE. William E. Schrumpf. *Farm Organization and Costs and Returns in Producing Potatoes in the St. John River Area of Aroostook County, Maine, 1937.* This study is completed in manuscript form. The study presents in detail (1) farm capital, (2) farm receipts, (3) farm expenses, (4) financial summary, (5) description of the farms, (6) the cost of growing, harvesting, storing, and selling potatoes, (7) returns from producing potatoes, and (8) the effect of size of farm business, yield rates, labor efficiency, capital efficiency, and farm balance on income and costs.

Farm Organization and Costs and Returns in Producing Potatoes in Central Maine, 1938. In this study 144 complete labor income records with especial detail on potato production were obtained from the commercial potato-producing area of central Maine during the summer of 1939. The records represent farms on which potatoes were an important source of income. Included were 14 farms on which similar information was obtained in 1929 and 1930. The 14 farms fall chiefly into two groups. In one group potatoes were the primary source of income and in the other potatoes were the secondary source. Preliminary figures show the labor incomes to be —$234 and $551, respectively, in the two groups. Potato prices for the 1938 crop were relatively low. Dairying was an important source of income in the second group.

On the 14 farms the potato acreage decreased 17 per cent from 1929-30 to 1938 while the number of animal units in dairy stock increased 37 per cent during the same period. The value of tractive power (horses, tractors, and trucks) increased 40 per cent in the

ten years. Practically all of this increase was in general-purpose tractors.

The Green Mountain variety of potatoes constituted 98.4 per cent of the potato acreage in 1929-30 and the Irish Cobbler 1.6 per cent. In 1938 the Green Mountain acreage made up 78.0 per cent of the potatoes planted, the Chippewa 10.1 per cent, the Katahdin 9.5 per cent, and the Irish Cobbler 2.4 per cent.

Potatoes represented the largest single source of receipts, accounting for about three-fourths in 1929-30 and one-half in 1938.

The average labor income on these farms in 1929-30 was $1,573 per farm. In 1938 the labor income averaged —$36 per farm.

MARKETING MAINE POTATOES. Charles H. Merchant and Maynard A. Hincks of the Maine Agricultural Experiment Station; and Gordon W. Sprague, Herbert W. Mumford, Jr., and Miss Gertrude Foelsch of the Cooperative Research and Service Division of the Farm Credit Administration, Washington, D. C. This study was undertaken cooperatively between the Farm Credit Administration and the Maine Agricultural Experiment Station on January 1, 1940.

The project includes four phases of marketing potatoes. These phases are (1) consumers' preferences for potatoes in the Metropolitan Boston Area, (2) the organization and operation of the wholesale market in Boston, (3) retail distribution of potatoes in the Metropolitan Boston Area, and (4) interregional competition of potatoes.

The study of consumers' preferences includes kind of potatoes and packages desired by consumers, amount and uses of potatoes, and relationship between retail prices and quality of potatoes purchased. For this phase of the study, over 3,400 families were interviewed and records obtained from them during the months of March and June, 1940.

Information was obtained concerning each of the five wholesale markets in Boston and the chain store warehouses. This material indicates the organization and operation of each of these markets in Boston, with emphasis on handling potatoes.

Information was obtained from more than 300 retail stores in the Metropolitan Boston Area during March and June, 1940. The information obtained includes a detailed description of the potatoes

sold and practices relative to merchandizing potatoes and food commodities in the store.

The fourth phase of the study deals with the competition Maine potatoes meet on the Boston market. Maine potatoes compete with potatoes from other production areas and indirectly with other food commodities from many sections of the country.

Results of each of the four phases of the study will be made available in preliminary mimeographed reports. The first release is available and deals with consumer preferences for potatoes on the Boston market.

POTATO FERTILIZATION. Joseph A. Chucka and Arthur Hawkins. *Fertilizer Experiments with Potatoes on Permanent Plots.* The 1939 potato yields on the permanent plots were the lowest on record. The check plots which received 2,000 pounds per acre of 4-8-7 produced an average yield of only 113 barrels per acre as compared with a ten-year average of 140 barrels. As is usually the case when low yields are obtained, the differences between treatments were small and somewhat inconsistent as compared with the data secured previously on these plots. The data secured on these plots during the past thirteen years have been summarized and will be published as a separate bulletin.

Fertilizer Experiments with Potatoes on Privately Owned Farms Throughout Aroostook County. In cooperation with Bailey E. Brown, Bureau of Plant Industry, United States Department of Agriculture.

Potash Source and Ratio Test. This test consisted of a comparison of muriate of potash, sulfate of potash, and nitrate of potash as sources of potash in potato fertilizers. The first two were used as single sources of potash in fertilizer mixtures where the nitrogen and phosphoric acid were kept constant at 4 and 8 per cent respectively and the potash was varied from 8 to 16 per cent. The nitrate of potash was used only in mixtures made with a combination of potash sources. All mixtures were applied at 2,000 pounds per acre. No significant differences in yield were obtained either between sources or amounts of potash used on the two farms where this test was conducted during 1939.

Source of Phosphorus Test. This test consisted of a comparison of eight different materials as a source of phosphorus in a 4-8-8 mixture applied at the rate of 2,000 pounds per acre on two different farms. The following materials were used and are listed in the

order of yields (highest to lowest) obtained: ordinary superphosphate, potassium meta phosphate, mono calcium chloro phosphate, fused phosphate, treble superphosphate, calcium meta phosphate, calcined phosphate, and dicalcium phosphate. However, only the last three mentioned materials produced yields appreciably lower than those produced by ordinary superphosphate.

Boron Test. This test consisted of a comparison of potato fertilizers with and without small amounts of borax on two different farms. The amounts of borax used were 0, 5, 10, and 20 pounds per acre. These amounts of borax were mixed with an 8-16-20 fertilizer which was applied at the rate of 1,000 pounds per acre. The average potato yields secured with the four treatments were 110, 107, 104, and 98 barrels per acre respectively for the mixtures containing 0, 5, 10, and 20 pounds of borax.

SPRAYING POTATOES FOR THE CONTROL OF EARLY BLIGHT. Reiner Bonde and Russell A. Hyre.[21] A comparison of various copper fungicides has been conducted on Aroostook Farm for a number of years for the purpose of finding a suitable substitute for Bordeaux mixture as a spray material for potatoes. This fungicide should be relatively cheap, give good control of certain diseases and insects, and also leave a colorless residue on the potato foliage. The latter qualification would facilitate roguing of seed plots and fields intended for certification. This feature is important in view of the great interest being shown in the methods of conducting seed plots and in the production of better seed potatoes.

The growing season of 1939 was unfavorable for the development of late blight at Aroostook Farm, although in the northern part of the County the disease caused large losses.

The spraying experiments conducted at Aroostook Farm in 1939 afforded data regarding the relative value of the different fungicides in controlling early blight which was very abundant.

Table 18 gives the comparative yields obtained in 1939 from one series of plots receiving various spray treatments applied with a horse-drawn wheel-traction outfit.

The data in Table 18 show that the plots sprayed with Bordeaux mixture yielded the highest. This fungicide gave the best

[21] Dr. Russell A. Hyre assisted the senior author in the spray comparisons of 1939 that are reported here. His services were made possible through funds supplied by the Sherwin-Williams Company, Cleveland, Ohio, through the Crop Protection Institute.

control of the early-blight disease which was reflected in the greater yield rate. "Spray cop" and "Chipman Copper Hydro 40" con-

TABLE 18

Yields for Green Mountain Plots Sprayed with Different Copper Spray Fungicides in 1939 with a Horse-Drawn Wheel-Traction Outfit. Land not in Potatoes in 1938

Fungicide[1]	Yield per acre[2]	
	Bushels	Barrels
"Alorco fungicide" [3]	261.6±8.3	95.3±3.0
"Basi cop" [4]	282.5±5.9	102.9±2.2
"Spray cop" [5]	291.0±5.0	106.0±1.8
"Chipman copper hydro 40" [6]	291.5±6.0	106.2±2.2
Bordeaux mixture	304.9±5.3	111.1±1.9

[1] All fungicides applied at rates equal in metallic copper content to that of 10–10–100 Bordeaux mixture.
[2] Yields based on 10 replicated plots, each with 312 feet of row for each fungicide.
[3] "Alorco fungicide" is said to contain 6 per cent metallic copper. Supplied by the Aluminum Ore Co., East St. Louis, Illinois.
[4] "Basi cop" is said to contain 52 per cent metallic copper. Supplied by Sherwin-Williams Company, Cleveland, Ohio.
[5] "Spray cop" is said to contain 34 per cent metallic copper. Supplied by General Chemical Co., 40 Rector Street, New York, N. Y.
[6] "Chipman Copper Hydro 40" is said to contain 40 per cent copper hydroxide or 26 per cent metallic copper. Supplied by Chipman Chemical Co., Bound Brook, N. J.

trolled early blight somewhat less effectively than did Bordeaux mixture, and the yield of potatoes was correspondingly less. The plots sprayed with "Basi cop" developed more early blight than did the plots treated with the other fungicides just referred to and the yield was slightly less. "Alorco fungicide" was not an effective fungicide for early-blight control in these tests.

Table 19 summarizes the yield data from plots in which Bordeaux mixture was compared with "Basi cop" and "Cuprocide 54Y." Bordeaux mixture gave better control of early blight in these plots which apparently resulted in higher yields.

Table 20 records the yield data from a series of plots sprayed with a tractor-drawn outfit, in which Bordeaux mixture was compared with "Basi cop" and "basic copper arsenate." Bordeaux

TABLE 19

Yields for Green Mountain Plots Sprayed with Different Copper Spray Fungicides in 1939 with a Horse-Drawn Wheel-Traction Outfit. Land in Potatoes in 1938

Fungicide[1]	Yield per acre[2]	
	Bushels	Barrels
"Basi cop" [3]	237±2.9	86±1.1
"Cuprocide 54Y" [4]	242±4.1	88±1.5
Bordeaux mixture	265±6.2	96±2.3
Unsprayed controls	206±4.0	75±1.5

[1] All fungicides applied at rates equal in metallic copper content to that of 10–10–100 Bordeaux mixture.
[2] Yields based on 13 plots for each treatment. Each plot consisted of 216 feet of row.
[3] "Basi cop" is said to contain 52 per cent metallic copper. Supplied by Sherwin-Williams Company, Cleveland, Ohio.
[4] "Cuprocide 54Y" is said to contain 47 per cent metallic copper. Supplied by Röhm and Haas Company, Philadelphia, Pa.

mixture was superior for the control of early blight in these tests and the yields were correspondingly greater in the Bordeaux plots. Data secured on the amount of disease present in the plots indicate that "basic copper arsenate" gave slightly better disease control

TABLE 20

Yields from Green Mountain Plots Sprayed with Different Copper Fungicides in 1939, with an 8-Row Tractor Outfit

Fungicide[1]	Yield per acre[2]	
	Bushels	Barrels
"Basi cop" [3]	227.7±2.3	82.5±0.8
"Basic copper arsenate" [4]	231.1±3.5	83.8±1.3
Bordeaux mixture	249.1±2.0	90.3±0.8
Unsprayed controls	206.4±4.0	75.2±1.5

[1] All fungicides applied at rates equal in metallic copper content to that of 10–10–100 Bordeaux mixture.
[2] Yields are means of 12 replicated plots for each treatment, each plot consisting of 375 feet of row.
[3] "Basi cop" is said to contain 52 per cent metallic copper. Supplied by Sherwin-Williams Co., Cleveland, Ohio.
[4] "Basic copper arsenate" is said to contain 56.2 per cent copper oxide (44.8 per cent metallic copper). Supplied by Sherwin-Williams Co., Cleveland, Ohio. For data on this arsenate see: Waters, H. A., *et al.* Basic copper arsenate—a new insecticide. Jour. Economic Entomology 32:142. 1939.

than "Basi cop." It also proved to be an excellent insecticide for the control of the Colorado potato beetle.

The spray comparisons of 1939 indicate that Bordeaux mixture is a better fungicide for the control of early blight than the other copper fungicides which were tested, being more effective and resulting in higher yield rates. The same difference was reported for 1938 with respect to the control of severe late blight. It should be recalled that in 1937, however, when early blight was less prevalent and when late blight was present only in moderate amount, all of the insoluble copper fungicides that were tested gave significantly higher plot yields than did Bordeaux mixture. This was in spite of the fact that the insoluble coppers were less effective in controlling late blight. The explanation lies in the retarding effect by Bordeaux mixture that is not compensated for unless there is considerable advantage through better disease and insect control.

The experiments indicate that the use of insoluble copper fungicides will render good commercial control of the diseases and result in satisfactory yields of potatoes provided a thorough spray program has been carried out. The fields sprayed with the insoluble copper fungicides can be expected to mature earlier than those that have been sprayed with Bordeaux mixture. This earlier maturity may be an asset in that it permits earlier harvesting of the crop. It is possible also that the earlier maturity of fields sprayed with the insoluble copper fungicides is associated with less spread of the virus diseases.

The chief advantage of the insoluble copper fungicides is that they are easier to prepare and apply than Bordeaux mixture. Also, their residue on the potato foliage is practically invisible, which aids in detecting the virus diseases and thus makes roguing easier.

Studies on the Control of the Potato Ring Rot Disease (Bacterial Wilt and Soft Rot). Reiner Bonde. The ring rot disease continues to be of major importance to the potato industry of Maine. Approximately 2,800 acres of seed potatoes were rejected for certification in 1939 because of this disease, and the loss to the seed potato farmers of Aroostook County was estimated at approximately $260,000. The growers of table-stock potatoes also experienced large losses from the disease during the past season.

State officials from several southern states have stated that the certified seed potatoes purchased from Maine growers in 1939

were relatively free from ring rot and that they produced very satisfactory crops. This statement should be encouraging to our growers of certified seed potatoes.

Control by Disinfection of Cut Seed. Experiments were conducted to determine the value of disinfecting cut seed potatoes for the control of ring rot. Freshly cut seed pieces from healthy stock were contaminated with the rotted material from tubers having the disease. The contaminated seed pieces were treated with the various disinfectants and then planted in the field. The number of plants that developed the disease in vines or tubers was recorded. The results obtained from this experiment are given in Table 21.

The studies showed that none of the disinfectants used were effective in controlling ring rot when used as instantaneous dip treatments. The mercurial hydrochloric-acid and the formaldehyde treatments were the only ones effective in killing the infection in the 5-minute soak treatment. These data show that some of the

TABLE 21

The Reduction of Potato Ring Rot Resulting from Treating Contaminated Freshly Cut Seed

Treatment	Concentration of solution	Per cent infection		
		Control	Instant dip	5 minute dip
Mercurial hydrochloric-acid dip	1 per cent acid and 1-500 bichloride of mercury		32.0	0.0
Mercurial acetic-acid dip	2 per cent acid and 1-500 bichloride of mercury		31.0	3.0
"Sanoseed" [1]	1 pound in 7.5 gallons water		38.0	3.0
"New Improved Semesan Bel" [2]	1 pound in 7.5 gallons water		37.0	2.0
Formaldehyde	2 per cent by volume		47.0	0.0
U. S. Rubber Co. disinfectant #61[3]	3 pounds in 30 gallons water		72.0	39.0
Bichloride of mercury long-time soak method (1½ hours)	1-1,000	0.0		
Not treated		81.0		

[1] Manufactured by Ansbacher-Siegle Corporation, Brooklyn, N. Y.
[2] Manufactured by Bayer-Semesan Company, Inc., Wilmington, Del.
[3] Manufactured by U. S. Rubber Company, Passaic, N. J.

disinfectants require more than a 5-minute treatment to protect seed pieces effectively from contamination by the ring rot organism.

The studies conducted indicate that sanitary measures and the treatment of cut seed merely give partial and temporary control of this disease. The only practical method by which ring rot can be controlled is by the elimination of all diseased seed stocks followed by planting with seed stocks that are disease-free.

Control by Resistant Varieties. One hundred and forty-five potato varieties and seedlings were tested regarding their resistance to ring rot. Two foreign varieties and several seedlings seemed to contract the disease less readily than did our commercially grown varieties. Other varieties were quite tolerant to infection and manifested mild symptoms which were difficult to detect under field conditions.

Seed Disinfection of Potatoes. Reiner Bonde. Studies were continued in 1939 to improve the acidulated mercuric dip method for the control of rhizoctonia. Chemical analyses made by the Chemistry Department demonstrated that the rate of loss of mercury from the treating solution was greatly reduced by the addition of a small amount of either hydrochloric or acetic acid. Field tests conducted in 1938 and 1939 showed that the acidulated treating solution retained its ability to control rhizoctonia for 25 or more successive treatments. The non-acidulated long-time soak method, in contrast, was not effective in controlling the disease after the solution had been used four times.

The acidulated mercuric dip method of treating seed potatoes has the advantage that it is much faster than the non-acidulated long-time soak method, the length of time for each treatment being reduced from 1½ hours to 5 minutes. Another desirable feature of the acidulated mercuric dip method is that the dirt and other debris accumulated in the solution as a result of treating the potatoes settles out rapidly and the solution soon becomes clear after each successive time used.

Acetic acid has the advantage of being less toxic than hydrochloric acid and therefore is more easily handled by farmers.

Purple Top Disease of the Potato. Reiner Bonde. The purple top disease was first noted by the writer in 1937 in Sebago potatoes being grown on Aroostook Farm. Surveys have shown that the disease is present in fields located in all parts of Aroostook County. It has been found most commonly in the Sebago, Katah-

din, and Chippewa varieties and has varied in amounts from a trace to 15 per cent of the plants being infected. The disease has been found to a less extent in Green Mountain and other varieties.

The disease may affect part or all of the plant. It is characterized by a distinct rolling of the apical leaves of the plant which develop reddish or purplish discolorations in those varieties which have pigmented foliage. The stems of infected plants may show various stages of internal discolorations which often are associated with wilting. The tubers from stems having symptoms of "purple top" may be wilted and spongy.

Experiments have shown that the tubers from plants having "purple top" fail to develop into healthy plants when used for seed. Many of the tubers failed to sprout normally and developed small secondary tubers in the soil without producing plants. Most of the plants which did develop were small and had spindling stems and gave poor yields. It is recommended that farmers rogue "purple top" from fields intended for seed purposes.

EFFECT ON POTATO YIELD OF DIFFERENT PERCENTAGES OF VIRUS DISEASES. Reiner Bonde and E. S. Schultz. Many commercial table-stock potato fields have some virus disease present, while only a few have relatively large amounts of virus diseases. This situation has raised the question regarding the amount of these diseases that may be present before the yield rate is materially affected.

Table 22 summarizes the results of experiments conducted in 1939 in which yield rates were obtained from seed stocks containing different amounts of mild mosaic, rugose mosaic, spindle tuber, and leafroll.

The data show that the different diseases if present in large amounts may affect the yield materially. Mild mosaic reduces the yield less severely than rugose mosaic, spindle tuber, or leafroll. Small percentages of the diseases studied do not affect the yield greatly, a fact that is not appreciated by growers. Disease did not reduce the yield rates significantly in these experiments until it had passed 30 per cent mild mosaic, 20 per cent rugose mosaic, 12 per cent spindle tuber, and 12 to 30 per cent leafroll depending on the variety. At 30 per cent, the reduction by leafroll ranged from 3 to 12 barrels per acre and the reduction by the other diseases was 18 to 20 barrels per acre. At 100 per cent, the reduc-

tion was more than 3⅓ times as great as at 30 per cent, except in the case of mild mosaic, probably because at the lower percentages the effect of disease was made up somewhat by expansion in yield of adjacent healthy hills.

TABLE 22

Effect on Potato Yield of Different Percentages of Virus Diseases in 1939

Yield rate method	Variety	Disease	Percentages of disease and yield rates					
			Trace	4%	12%	20%	30%	100%
In bus. per acre*	Gr. Mt.	Mild mosaic	345.8	343.0	343.1	337.5	313.8	239.5
	Gr. Mt.	Rugose mosaic	381.3	363.0	342.8	347.0	327.4	141.8
	Gr. Mt.	Spindle tuber	329.4	314.2	293.9	289.6	281.1	120.4
	Gr. Mt.	Leafroll	370.8	380.3	331.2	333.4	317.5	139.5
	I. Cob.	Leafroll	230.0	235.3	238.6	222.8	222.1	152.8
	Chippewa	Leafroll	333.4	332.8	336.5	318.3	300.3	110.7
In bbls. per acre	Gr. Mt.	Mild mosaic	126.0	125.1	125.1	123.0	114.4	87.3
	Gr. Mt.	Rugose mosaic	138.9	132.3	124.9	126.5	119.3	51.7
	Gr. Mt.	Spindle tuber	120.1	114.5	107.1	105.5	102.5	43.9
	Gr. Mt.	Leafroll	135.2	138.6	122.0	121.5	115.8	50.9
	I. Cob.	Leafroll	83.8	85.8	86.9	81.2	80.9	55.7
	Chippewa	Leafroll	121.1	120.9	122.2	115.6	109.2	40.2
Reduction in bbls. per acre	Gr. Mt.	Mild mosaic	—	0.9	0.9	3.0	11.6	38.7
	Gr. Mt.	Rugose mosaic	—	6.6	14.0	12.4	19.6	87.2
	Gr. Mt.	Spindle tuber	—	5.6	13.0	14.6	17.6	76.2
	Gr. Mt.	Leafroll	—	I†	13.2	13.7	19.4	84.3
	I. Cob.	Leafroll	—	I	I	2.6	2.9	28.1
	Chippewa	Leafroll	—	0.2	I	5.5	11.9	80.9
Reduction in percentage	Gr. Mt.	Mild mosaic	—	0.7	0.7	2.4	9.2	30.7
	Gr. Mt.	Rugose mosaic	—	4.8	10.1	8.9	14.1	62.8
	Gr. Mt.	Spindle tuber	—	4.7	10.8	12.2	14.7	63.4
	Gr. Mt.	Leafroll	—	I	9.8	10.1	14.3	62.4
	I. Cob.	Leafroll	—	I	I	3.1	3.5	33.5
	Chippewa	Leafroll	—	0.2	I	4.5	9.8	66.8

*Yield rate calculated from yields of 8 plots for each lot of seed compared. The plots were arranged in a magic square and each consisted of 50 hills spaced 1 foot apart in the row.
† "I" indicates an increase. All increases were too small to be significant.

COOKING QUALITY OF POTATOES. Marion D. Sweetman. Investigations this year included ratings of the mealiness of certain potato samples from the Aroostook Farm plots and from the Blackstone plots.

As in previous years, in the fertilizer level tests at Aroostook Farm, comparing effects of the application of the standard (4-8-7) fertilizer at 0, 2,000-pound, and 3,000-pound levels, the four varieties tested produced the mealiest tubers at the zero level with a marked decrease at the 3,000-pound level.

This year potatoes grown with fertilizers varying in potash

from 8 to 16 per cent showed no marked difference in mealiness. Although the potatoes grown on plots receiving heavy broadcast applications of fertilizer showed decreased mealiness, there was comparatively little difference in mealiness between them and those grown with potash in the form of C.P. salts. The mealiness of all samples of the Green Mountain variety was superior, perhaps due to the particular weather conditions which tended to mask other factors.

FLORIDA TEST PLOT. Geddes W. Simpson and Donald H. Perrin. The value of a Florida test to the seed-potato industry having been amply demonstrated, an enlarged test plot was provided for during the winter of 1939-40. Samples were taken from all of the plots entered in the 1939 foundation seed program with the exception of two plots of Katahdin found to have ringrot infection. These foundation seed plots accounted for 82 out of 302 samples. Fields from which the other 220 samples were taken were selected by the Department of Agriculture on the basis of information available as a result of the second field inspection and a knowledge of surrounding fields or because the fields were known to be seed plots. Only fields believed to offer some promise as sources of seed for local use during the coming year were included.

All samples were brought to Aroostook Farm where treatment with ethylene chlorhydrin was carried out.

Shipment was made to south Florida following a period of a week during which the potatoes were kept warm to aid in sprouting.

Eighteen acres were needed in Florida to accommodate the test. Each sample was planted in a row by itself. One hundred tubers were split; the remainder were planted whole. Each sample was given a number and after being planted all samples were handled on the basis of this number until reports were ready to be sent to the owners of each lot. In this way, those who made the disease readings did not know who owned any particular lot and could make the readings without bias.

Readings were started on New Year's Day and were continued until the plants froze down on the night of January 27. At that time each lot had been read twice by different individuals and many lots had been read a third time.

Weather conditions were very favorable for the expression of leafroll symptoms. Mosaics also were easily read.

The response of the different varieties to ethylene chlorhydrin varied considerably. From the standpoint of growth response, Sebago and Chippewa appeared to be most effectively treated. Katahdin was next. Mountains responded slowly and Cobblers came very unevenly, a small percentage of Cobbler tubers not starting to sprout until Sebago and Chippewa were in bloom. It is worth noting that, at the time the plants were killed, Sebago was the only variety that had produced potatoes that could be shipped as U. S. #1.

There was considerable variation in the amount of disease found in the various lots sampled. Certain lots were found to be nearly free from disease, the samples grown in Florida being clean. In one case, however, three out of every five tubers were found to be diseased.

In those cases where the disease content of the samples justified it, lots of seed were recommended as being apparently certifiable in 1940.

Table 23 indicates the number of lots represented in Florida and the number recommended.

INSECTICIDES IN RELATION TO THE CONTROL OF POTATO VIRUS DISEASES. Geddes W. Simpson. In the spring of 1938

TABLE 23

Number of Lots of Seed by Variety Entered in 1939-40 Florida Test and Number of Lots Recommended as Suitable for Planting in 1940

Variety	1939 Foundation Seed Program		Certified Seed	
	Number of lots Represented	Number of lots Recommended	Number of lots Represented	Number of lots Recommended
Bliss	0	0	2	1
Chippewa	8	4	29	10
Irish Cobbler	13	13	47	30
Earlaine No. 2	0	0	2	2
Houma	1	1	3	3
Katahdin	9	9	34	28
Mesaba	0	0	1	1
Green Mountain	22	21	85	42
Russet	0	0	3	0
Sebago	26	22	4	3
Spaulding Rose	1	1	4	1
Warba	0	0	1	0
All varieties	80	71	215	121

a project was outlined for a study of the effect of insecticides on the spread of leafroll and of mosaic. A considerable amount of seed that had been indexed in the winter of 1937-38 was available. This seed was used to plant a block of 154 rows, each of which was 160 feet long. Tubers known to have leafroll and others known to have mosaic were planted at intervals in each row. On a percentage basis, 4 per cent of the hills were thus known to be infected with mosaic and 3 per cent with leafroll. Each diseased hill was staked. Before harvest all diseased hills, together with the tubers produced by them, were removed and discarded. In this way it was definitely known that all diseased hills found during the summer of 1939 came from tubers infected as a result of spread of disease in 1938.

The test was laid out to include sprayed and unsprayed rows. Half of the sprayed rows were treated with 10-10-100 Bordeaux mixture. The remainder were sprayed with "Basi cop." These fungicides were used to control late blight.

One-third of the rows treated with Bordeaux received "Black Leaf 40" as well, at the rate of one pint to 100 gallons. Another third received "Lethane 440" at the rate of one quart to 100 gallons. The remaining third received no insecticide.

One-third of the rows treated with "Basi cop" received "Black Leaf 155" as well, at the rate of four pounds in 100 gallons. Another third received ground cubé containing 4 per cent rotenone, at the rate of four pounds in 100 gallons. The remaining third received no insecticide.

Each treatment was applied to 4 plots consisting of 6 rows each. The arrangement of the plots in each replication was determined by lot and was thus a random arrangement. Two rows receiving neither fungicide nor insecticide were included at both ends as well as between each block of 36 rows.

At harvest time enough tubers were saved from the plot to reproduce the planting in 1939. The tubers were picked up along the rows thus providing a random sample from the row. Tubers were taken from all unsprayed rows and from each of the four middle rows in each six-row plot. These tubers were stored over the winter in marked boxes and were cut and planted in the spring of 1939 so as to reproduce exactly the arrangement laid out in the spring of 1938. The same spraying program also was repeated.

The diseased plants appearing in the 1939 planting were counted and the percentage of infection figured on the basis of the total number of hills in the 24 rows in each treatment.

The results are presented in Table 24 as percentages of infection.

Rugose mosaic was found to have spread into this block, probably from other plots in the immediate vicinity.

As is usually the case in Aroostook County, the unsprayed rows died earlier than sprayed rows. Less spread of disease in these rows is due to early maturity. The rows sprayed with Basi cop died before those sprayed with Bordeaux but both lived beyond the period of maximum spread of disease.

The data were treated statistically[22] and it was found that the differences were not significant.

TABLE 24

Percentage of Infection Occurring in 1938 in Plots Sprayed with Various Materials

Treatment	Leaf roll	Mild mosaic	Rugose mosaic
Unsprayed	0.4	0.8	0.0
Bordo Black Leaf 40	2.7	3.8	0.2
Bordo	1.5	2.2	0.0
Bordo—Lethane 440	1.8	2.5	1.1
Basi cop—Black Leaf 155	3.3	1.7	0.4
Basi cop	1.4	1.8	0.3
Basi cop—Cubé	1.9	1.0	0.0
Unsprayed	1.0	0.4	0.0

In the fall of 1939 tubers were harvested as indicated above except that this time diseased hills were not removed.

The material was placed in storage until just before planting time when each tuber was cut to determine the amount of net necrosis in each lot.

The results are indicated in Table 25 and are presented as percentages based on the total number of tubers examined from each treatment.

The data were examined mathematically[22] and it was found

[22] The statistical analysis was made by Mildred Covell, Assistant Statistician, Maine Agricultural Experiment Station.

that the variability was such that for this experiment most of the differences were not significant. The amount of net necrosis found in tubers taken from plots sprayed with Basi cop and Black

TABLE 25

Percentage of Net Necrosis Found in Tubers Harvested from Plots Sprayed with Various Materials

Treatment	Net necrosis
Unsprayed	2.2
Bordo—Black Leaf 40	3.6
Bordo	2.5
Bordo—Lethane 440	4.1
Basi cop—Black Leaf 155	1.7
Basi cop	2.9
Basi cop—Cubé	1.4
Unsprayed	0.6

Leaf 155 and from those sprayed with Basi cop and cubé was, however, significantly less than the amount of net necrosis present in tubers harvested from plots sprayed with Bordo and Lethane 440.

A COMPARISON OF SHELL HORTICULTURAL SPRAY AND BLACK LEAF 40 IN THE CONTROL OF APHIDS ON POTATOES. Geddes W. Simpson. Through the efforts of Mr. J. W. J. O'Dea of the Shell Oil Company, it became possible during the summer of 1939 to test the effectiveness of Shell Horticultural Spray in the control of aphids on potatoes in Aroostook County.

Due to mechanical difficulties, it proved impossible to apply this material as early in the season as conditions warranted. Nevertheless, an excellent opportunity was afforded on August 14, 1939, to test the effectiveness of this spray as an aphicide.

A block of 72 rows had been set off earlier for this purpose. The rows were of sufficient length to permit the digging of 1/100-acre plot in each row. Six-row plots replicated four times at random were utilized for the insecticidal sprays. The whole block was sprayed throughout the season with Bordeaux mixture for the control of late blight.

Insect records were made, in part, by sweeping with an insect

net; in part, by making counts on tagged leaves of which five were chosen at random from the second and five from the fourth rows in each six-row plot. Aphids were thus counted on forty leaves in each of the three treatments. The leaves, picked at random, ranged in position from the top to the bottom of the plants chosen. Some idea of the ability of the material to penetrate to all parts of the plant was thus obtained.

Aphid counts were made just before the sprays were applied, again 48 hours after application, and a third time a week after the application of the spray.

Sweepings for the other insects were made 48 hours after the sprays were applied.

The Shell Horticultural Spray was used as recommended by the Shell Oil Company and was applied with the machine developed by the Company for this purpose. The Black Leaf 40 was used at the rate of 1 pint to 100 gallons of spray. This material was applied with a power-take-off sprayer. A sulfonated alcohol was added to the latter spray at the rate of one ounce to 100 gallons. The check plots received only the Bordeaux mixture (10-10-100) that was applied to the entire block throughout the season. Applications of Bordeaux were not made at the time the insecticides were applied during the afternoon of August 14, 1939. On this date weather conditions were apparently satisfactory for the greatest effectiveness of the applications.

It will be seen from Figure 6 that the average initial infestation of the several series of plots varied slightly. This variation is no greater than is to be expected in random sampling of aphid populations on potatoes.

The recount of the tagged leaves made 48 hours after the application of the sprays indicates (Figure 6) that the aphid population was materially reduced in the treated plots. This reduction was still evident a week after the treatment. At that time some increase in population was noted, particularly in the check plots.

In Table 26, detailed figures are presented for winged and wingless aphids of the three species present in the experimental plots.

Information on the effect of the treatments was obtained for potato flea beetles, tarnished plant bugs, and ladybird beetles. In all three cases some reduction was noted.

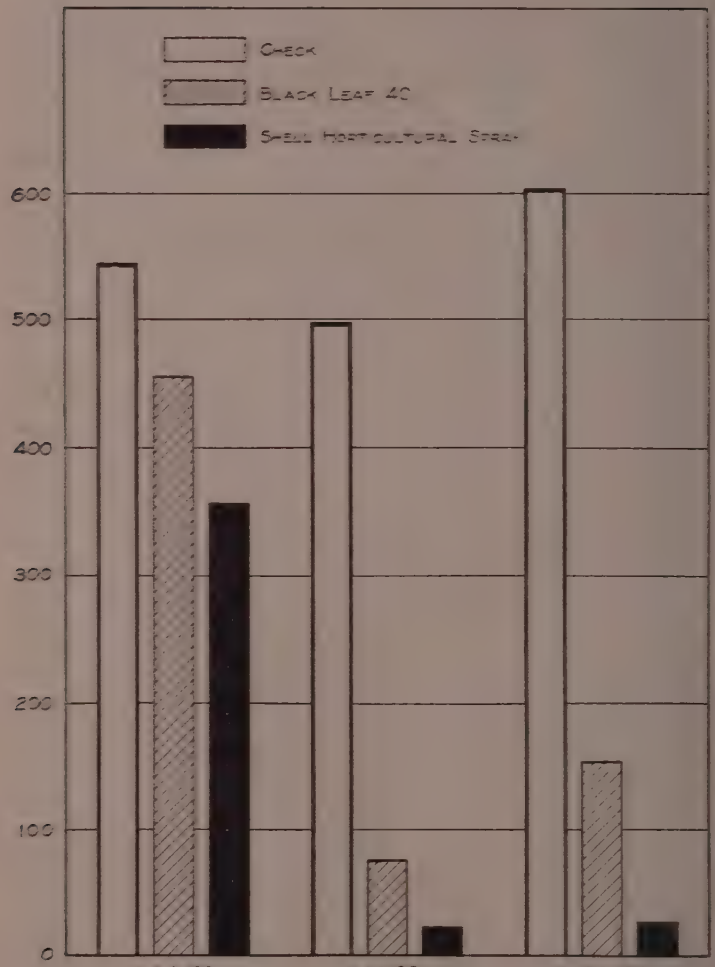

FIG. 6. Average number of aphids on ten leaves before and after treatment with two insecticides.

Yields (Table 27) were measured at harvest time although the block was not laid out with this in mind in the first instance and the results obtained can be taken as interesting indications

only. The actual differences obtained are so slight that they may be due to experimental error.

TABLE 26

Number of Aphids on 40 Tagged Leaves before and After Treatment

Treatment		Date		
		8/14/39	8/16/39	8/22/39
Check	Winged buckthorn aphid	32	45	302
	Wingless buckthorn aphid	21,855	19,747	24,109
	Winged potato aphid	7	14	24
	Wingless potato aphid	235	250	243
	Winged peach aphid	1	9	4
	Wingless peach aphid	245	245	690
Shell Horticultural Spray	Winged buckthorn aphid	26	1	2
	Wingless buckthorn aphid	14,375	933	1,012
	Winged potato aphid	5	8	13
	Wingless potato aphid	[illegible]	[illegible]	[illegible]
	Winged peach aphid	6	2	12
	Wingless peach aphid	409	20	114
Black Leaf 40	Winged buckthorn aphid	21	9	26
	Wingless buckthorn aphid	18,305	2,938	6,301
	Winged potato aphid	10	11	15
	Wingless potato aphid	232	153	269
	Winged peach aphid	12	9	6
	Wingless peach aphid	679	259	346

TABLE 27

Yields in Bushels per Acre

Check	212
Black Leaf 40	218
Shell Oil	223

The results obtained indicate that the materials used are capable of reducing insect populations on potatoes. These reductions do not appear to have influenced yields appreciably. It appears likely that earlier applications in conjunction with more favorable moisture relationships would result in greater differences in yield.

INSECTS IN RELATION TO THE TRANSMISSION OF VIRUS DISEASES OF POTATOES. Geddes W. Simpson. Experimental work carried on for several years served as a basis for the development of a foundation seed program in 1939. As outlined, this program

extends the research phase of the project into a larger field and makes it possible to start on an extensive scale to aid in the selection of seed stocks and of seed plot locations; to assist many growers in tuber unit planting; to supervise the roguing and sampling of these seed plots; and to aid in the early harvesting of seed for subsequent seed plots.

Special funds made it possible to extend a survey of potato insects to eastern and central Maine. From similar information gathered earlier in Aroostook, it would appear desirable to obtain several seasons' results before attempting to reach conclusions. Eventually, it should be possible to determine the locations most suitable for the production of foundation seed in so far as insects are concerned in that work. In certain small areas along the coast, aphids were found to be practically nonexistent in 1939, a year when aphids were abundant in other parts of the State. Should this condition prevail over a period of years, a new source of income from the sale of seed potatoes may be opened up to growers in this area.

ROGUING SERVICE FOR PRODUCERS OF FOUNDATION SEED POTATOES. Geddes W. Simpson and Reiner Bonde. The roguing service for producers of foundation seed potatoes was begun in 1939 for the purpose of improving the quality of seed potatoes produced in Maine. This service has been in operation for two seasons and it is believed that progress is being made. The fact that the seed stocks entered for certification in 1940 were relatively good in spite of the severe spread of disease in 1939 (becoming apparent in early 1940) can be attributed in part to the roguing service. This service has stimulated interest in the production of better seed stocks, and many farmers not entered in the program are conducting their own seed plots following the practices as outlined by the Experiment Station. It is felt that if farmers continue to show this interest the quality of our seed potatoes will be improved. In many cases farmers have learned that disadvantages in the location of seed plots are more than made up in the better quality of seed obtained from truly isolated plots.

The Experiment Station received, in the spring of 1939, applications from 63 growers for the roguing of approximately 225 acres of tuber unit seed plots.

The seed used in planting these seed plots was found, in most cases, to be satisfactory for the purpose. A few lots, especially of Chippewa seed, were from sources not tested in Florida and were found to contain considerable leafroll which could not be successfully removed during this particular season.

Planting, in most cases, was done during the middle of May. Roguing could be started early in July; in a few instances late in June.

The symptoms of mosaic and of leafroll were easily seen, thus making the early roguings quite effective. Additional help was employed during the first two weeks of the season to speed the removal of diseased plants.

Roguing was continued for a period of six weeks or longer, depending on the apparent need in each case.

In all cases, save one, seed for another year was "early-harvested" as soon as tuber development permitted. In most cases the tops were removed as soon as the average weight of tubers per hill reached one pound. These tubers were then allowed to harden off in the ground for a period of ten days to two weeks when they were dug and stored.

A representative sample of tubers was taken from each seed plot before digging. These samples were sent to Florida for testing during the winter. On the basis of the returns from this test, seed stocks were approved or disqualified as foundation seed sources. The results are indicated in Table 28.

TABLE 28

1939 Foundation Seed Program: Summary of Pertinent Information

Variety	Total number of plots	Number of plots qualifying as foundation seed	Total acreage	Acreage qualifying
Chippewa	8	4	17.4	4.3
Cobbler	13	13	39.6	39.6
Houma	1	1	1.0	1.0
Katahdin	12	10	32.2	28.5
Mountain	19	18	107.8	105.8
Sebago	29	25	26.3	23.5
Spaulding Rose	1	1	1.5	1.5
All varieties	83	72	225.8	204.2

Most of the seed produced in 1939 has been used by its owners for the planting of certified seed in 1940. In a few instances, surplus seed has been offered for sale. Some of this seed is being used in 1940 by other growers who entered the foundation program this year. Markets were not found in Maine for all of the Green Mountains and Cobblers produced, and consequently some seed of these varieties was sold outside the State.

The ultimate aim of the roguing service is to supply an amount of seed adequate for the planting of most of the certified seed acreage needed by that part of the seed potato industry engaged in raising seed for growers to the south of Maine. Such a program may be years in developing but can, doubtless, be carried on to the distinct advantage of the industry, not only in Maine, but in those states that buy seed from Maine for the production of table stock.

The ultimate success of the foundation program depends in large measure on the willingness of growers to do everything they can to facilitate roguing. As time goes own, it is to be hoped that more growers will be able to plant early in isolated locations on soil that will perimt normal and rapid development of foliage on which rests the diagnosis of virus diseases. Even under ideal conditions, roguing is apt to be difficult. When cultural conditions interfere with growth, or planting is late, it is extremely difficult to make progress toward better seed.

Considerable tuber indexing was undertaken in connection with an isolated seed farm now available to the Experiment Station for the first time. Seed stocks of a number of new varieties were tested, in cooperation with the Department of Plant Pathology, for freedom from latent mosaics as well as the more easily recognized virus diseases. Small stocks of superior seed have been planted for increase and eventual distribution through the Foundation Seed Program.

SMALL FRUIT CROPS

STRAWBERRY BREEDING. Russell M. Bailey and Iva M. Burgess. Some strawberry breeding work is in progress in the effort to develop better adapted late fruiting varieties. From crosses

involving Howard 17, Aberdeen, Fairfax, Blakemore, and Big Joe, twenty-six of the most promising seedlings are now in their third trial.

Blueberry Investigations. *Breeding and Selection.* Frederick B. Chandler and Irvin C. Mason. During the fruiting season of 1939 selections of *V. atrococcum* were made in North Lebanon. This species is a high-bush type with black fruit. It was selected because it grows on somewhat higher land and may be more hardy than *V. corymbosum.* Several crosses of this plant were made in June, 1940, with some of the named varieties of *V. corymbosum.* Attempts were made to select large-fruited plants of *V. vacillans,* which is an economically important species in the mountains of West Virginia and Pennsylvania.

Burning. Frederick B. Chandler and Irvin C. Mason. In a previous publication[23] it was stated that the burning of blueberry land every other year produced a greater yield of blueberries than burning every three years. However, the data on these plots over a longer period of time indicate that the yield is decreasing on the plots burned every other year. The results of this study were published in a scientific journal in an article the abstract of which will be found in the back of this bulletin in the section on Publications.

Chemical Study of the Blueberry Fruit. Frederick B. Chandler and Irvin C. Mason. Samples of blueberries were preserved to study pH, sugar content, pectin content, and the percentage moisture of the blueberry fruit. The preliminary studies show that there is some pectin in blueberries. A study of the moisture content in fresh berries shows a seasonal variation from 84.7 per cent to 86.4 per cent. A study of dried blueberries showed that the best quality product had about 22 to 30 per cent moisture. Dried blueberries with over 35 per cent moisture molded and berries with less than 17 per cent moisture were too hard.

Weed Control. Frederick B. Chandler and Irvin C. Mason. Grass is the most serious weed in some blueberry fields. If the grass can be controlled, fertilizers may be added and the yield of berries greatly increased. This year geese were pastured in blueberry fields to see if they would satisfactorily control grass and their feeding up to June 30th kept the grass very short.

[23] Me. Agr. Exp. Sta. Bul. 380.

Transplanting. Frederick B. Chandler and Irvin C. Mason. In April and May most of the selected low-bush blueberry plants were transplanted to a new location to study the effect of soil treatment, peat, and fertilizer on the spread of plants. This experiment will also test the yield, size, and quality of fourteen varieties of the blueberry plants which have been selected in Maine. The effect of burning on the spread of blueberry plants also will be studied. This experiment includes over 300 plants.

High-Bush Blueberry Culture. Frederick B. Chandler and Irvin C. Mason. This year three plantings of high-bush blueberries were made, one at Highmoor Farm, Monmouth, one at Cherryfield, and one at Deblois. These plantings have several of the named varieties and two of the Station's selections. The plantings are to study the effect of different rates of fertilizer and mulch on the yield of blueberries.

BLUEBERRY INSECTS. Frank H. Lathrop. Studies of the blueberry fruit fly and the blueberry thrips were continued during the year 1939-40.

Blueberry Fruit Fly (*Rhagoletis pomonella* Walsh). In combating the fruit fly, many blueberry growers make three applications of calcium arsenate dust during the season, to their most productive fields. On less productive areas, two applications are usually made. The increased amount of calcium arsenate seems to aggravate the injurious effects that the insecticide has upon the blueberry plants. It seemed possible that the injury to the plants might be reduced by the substitution of a derris dust in place of the third application of calcium arsenate, with satisfactory control of the fruit fly, at a reasonable cost for the insecticides. In the summer of 1939, two 20-acre plots of blueberry land were selected. One-half of each plot was given two applications of calcium arsenate and the adjoining area was dusted with two applications of calcium arsenate, followed by one application of ground derris and pulverized clay, the mixture containing 2 per cent rotenone.

The calcium arsenate was applied on July 16 and July 23. The derris dust was applied on August 7. Examination of samples of the berries from the treated plots at harvest time showed no less fruit fly infestation on the plots to which the derris dust was applied than occurred on the plots which were dusted with calcium arsenate only. In view of the promising results secured from some

of the experimental applications of derris dust during the past few years, the negative results secured in 1939 should not discourage further tests of derris.

Blueberry Thrips (*Frankliniella vaccinii* Morgan). The thoroughly unsatisfactory results secured from burning over the thrips-infested areas during the season of 1938-39, made it appear undesirable at this time to continue experiments with burning for thrips control. In the spring of 1940, experiments were undertaken on the use of soil insecticides.

Dichlorethyl ether and carbon disulphide emulsion were applied to plots of thrips-infested blueberry land in the early spring of 1939. The treatments failed to reduce the infestation on the plots. In view of the preliminary nature of the tests, further experiments will be conducted during 1940-41.

ANNOUNCEMENTS

Mr. W. S. Nutter was appointed to the Station Council as a Trustee representative to take the place of Mr. J. T. Gyger.

Mr. R. H. Boothby succeeded Mr. R. Elliott as representative on the Council from the Maine Livestock Breeders Association.

Mr. W. J. Ricker replaced Mr. W. H. Conant on the Station Council as representative from the Maine Pomological Society. Mr. Conant resigned as the Maine Pomological Society representative.

Mr. Merle T. Hilborn, Assistant Plant Pathologist, was granted the degree of Doctor of Philosophy from Yale University in June, 1940.

Miss Joan H. Stacy, Assistant in Biology, resigned, her resignation effective January 31, 1940. Miss Marie L. Maguire was appointed to fill the vacancy left in Biology by the resignation of Miss Stacy. Miss Maguire's appointment becomes effective July 1, 1940. Miss Maguire is a graduate of Bennington College, class of 1937.

Maynard A. Hincks was appointed as Assistant in Agricultural Economics, appointment effective January 16, 1940. Mr. Hincks is a graduate of the University of Maine, class of 1932, and received his Master's Degree also from the University of Maine

in 1935. Mr. Hincks is to assist in the studies in marketing and consumer preference in potatoes.

Donald H. Perrin was appointed as Assistant in Entomology, appointment effective September 6, 1939. Mr. Perrin is a graduate of the University of Maine, class of 1939. He will assist in the work with the Foundation Seed Program and the Florida Test with potatoes.

Dr. A. Frank Ross was appointed Associate Biochemist, appointment to become effective July 1, 1940. Dr. Ross did his undergraduate work at the University of Missouri and received his Doctorate at the University of Wisconsin. He has been working under a Fellowship at the Rockefeller Institute for Medical Research. Dr. Ross will undertake chemical studies with the potato virus diseases.

Mr. Frank E. Upton was appointed as Assistant in Agronomy, appointment to become effective July 1, 1940. Mr. Upton is a graduate of the University of Maine in the class of 1940. Mr. Upton will assist in the Potato Seed Program and with storage studies with controlled temperatures and humidities in relation to the development of stem-end browning and net necrosis.

Mr. John S. Getchell has been appointed as Assistant in Bacteriology, appointment to become effective July 1, 1940. Mr. Getchell is a graduate of the University of Maine, class of 1936, and received his Master's Degree from Maine in 1939. Mr. Getchell has been on temporary employment in the Station since January 1, 1940.

Mr. Joseph L. Harrington has been appointed as Assistant in Agronomy, the appointment to become effective July 1, 1940. Mr. Harrington is a graduate of the University of Maine, class of 1940.

Mr. Edward O. Merrill has been appointed as Assistant in Chemistry, the appointment to become effective July 1, 1940. Mr. Merrill is a graduate of the University of Maine in the class of 1938. Mr. Merrill has been temporarily employed in Station work since June 6, 1938.

Mr. C. Byron Sibley has been appointed as Assistant in Bacteriology, the appointment to become effective July 1, 1940. Mr. Sibley is a graduate of the University of Maine in the class of

1937. Mr. Sibley has been temporarily employed in Station work since June 14, 1937.

PUBLICATIONS

The Station is organized so that the work of investigation is distinct from the work of inspection. The results of investigation are published in the bulletins of the Station and in scientific journals, both foreign and domestic. The bulletins for the year, including this Report of Progress, make up the complete annual report. The results of the work of inspection are printed in publications known as Official Inspections. These are paged independently of the bulletins and may be bound with the annual report as an appendix thereto. Miscellaneous publications, consisting of newspaper notices of bulletins and newspaper articles which are not paged consecutively and for the most part are not included in the annual report, also are issued during the year.

BULLETINS ISSUED IN 1939-1940

No. 398. The Organization and Management of 95 Dairy and Cash Crop Farms in Androscoggin and Oxford Counties, Maine. 72 pages.
No. 399. Receipts, Utilization, and Prices of Milk and Cream in Maine Milk Control Areas. 112 pages.
No. 400. Report of Progress for Year Ending June 30, 1940. 110 pages.

OFFICIAL INSPECTIONS ISSUED IN 1939-1940

No. 172. Commercial Feeding Stuffs, 1938-1939. 46 pages.
No. 173. Commercial Fertilizers, 1939. 52 pages.
No. 174. Commercial Agricultural Seeds, 1939, and Fungicides and Insecticides, 1939. 36 pages.
No. 175. Foods and Drugs. 120 pages.

MISCELLANEOUS PUBLICATIONS ISSUED IN 1939-1940

No. 559. A Roguing Service for Producers of Foundation Seed Potatoes.
No. 560. 1939 Vegetable Variety Trials and List of Recommended Varieties.
No. 561. Consumer Preferences for Potatoes in Boston.

ABSTRACTS OF PAPERS PUBLISHED BY THE STATION IN 1939-1940 BUT NOT INCLUDED IN THE BULLETINS

A complete list of all the bulletins issued by and from the Station in 1939-1940 is given on page 279 of this Report. The following pages contain abstracts of the papers published during the year and not included in the Bulletins or Official Inspections.

1937 AND 1938 ADDITIONS AND CORRECTIONS TO THE LIST OF CAUSES OF FUNGUS AND BACTERIAL PLANT DISEASES IN MAINE[1]

This list is a continuation of the series begun with the publication of "List of causes of fungus and bacterial plant diseases in Maine to 1936 inclusive. Plant Disease Reporter Suppl. 105. 1938." In the present list 115 fungi and bacteria are listed as having been found on 55 host plants. These records are either new reports of a particular disease on a host, or the extension of the range of a previously reported disease. A few corrections are made which supplement the previous list.

THE SYNONYMY OF FOMES FOMENTARIUS[2]

Twenty-one synonyms of *Fomes fomentarius* are listed in this article. According to the International Rules of Nomenclature the fungus should be cited as *Fomes fomentarius* (Fr.) Kickx and not as *Fomes fomentarius* (L.) Gill., as Kickx published it as such previous to Gillet. Kickx is also responsible for raising Fries' sub-genus *Fomes* to generic rank, and the genus becomes *Fomes* (Fr.) Kickx, and not *Fomes* (Fr.) Gill. If authorities earlier than Fries are cited the fungus should be designated as *Fomes fomentarius* (L. ex Fries) Kickx.

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[1] This is an abstract of a paper by M. T. Hilborn and F. H. Steinmetz having the same title and published as Plant Disease Reporter Suppl. 113, pp. 21-26. 1939.

[2] This is an abstract of a paper by M. T. Hilborn and David H. Linder having the same title and published in Mycologia 31:418-419. 1939.

Potato Tuber Net-Necrosis and Stem-End Browning Studies in Maine[3]

Net necrosis of the potato tuber is an occasional transitory symptom of leafroll in certain varieties and is distinguishable microscopically and macroscopically from stem-end browning of similar tubers. The ratio of net necrosis to leafroll may vary from 1/1 to 1/9, and averaged 1/3.3 in one test. Net necrosis is more common in larger tubers, and stem-end browning in smaller tubers. Stem-end browning varies with the seasons in a region and with regions during any season. It has no correlation with plant vigor and yield rate in the next generation of plants, and is not perpetuated in the tubers from one generation to the next. No definite correlation was found between stem-end browning and various possible causes, such as soil type, previous occurrence in the soil, previous fertilizer treatment of the soil, soil nutrients, pH of the soil, soil water, presence of recognizable virus disease, origin of commercial seed strain, injury to the parent plants, time and manner of digging, and certain storage conditions. However, through successive seasons it appears more troublesome on certain farms than on others and in certain fields of those farms than in others. Net necrosis and stem-end browning both require some weeks to reach their maximum development in storage.

Comparative Studies of the Bacteria Associated with Potato Blackleg and Seed-Piece Decay[4]

This paper gives the results of a study of 62 pathogenic bacterial organisms found associated with potato blackleg, seed-piece decay, and other soft-rot diseases. The bacteria studied originated from different sources in Maine and South Carolina and were compared regarding their morphological, physiological, and pathological characteristics.

A number of bacteria, each causing both blackleg and soft rot of potato in Maine and South Carolina, were very similar,

[3] This is an abstract of a paper by Donald Folsom and Avery E. Rich having the same title and published in Phytopath. 30:313-322. 1940.

[4] This is an abstract of a paper by Reiner Bonde having the same title and published in Phytopath. 29:831-851. 1939.

one to another, and were not distinguishable from authentic cultures of *Erwinia carotovora* (Jones) S.A.B. The cultures were identical in all of the physiological characteristics except in the production of gas on dextrose, sucrose, and lactose and in the production of indole.

The isolates answering the morphological and physiological characteristics of *E. carotovora* varied greatly in degree of pathogenicity. Some were only weakly parasitic, while others were quite virulent and destructive.

Bacteria capable of causing blackleg and seed-piece decay (a form of soft rot) were secured from a wide range of sources. This lends support to the view that much blackleg and seed-piece decay may originate from contamination that occurs after the seed tubers have been cut, instead of from diseased seed. The blackleg organism was found intimately associated with certain insects commonly present in decaying plant tissue. It was found capable of remaining viable within the puparia of the cabbage maggot after exposure to a severe northern Maine winter. It was very prevalent in the soil from Charleston, South Carolina.

An undescribed organism with polar flagella was found to be responsible for a yellow seed-piece decay in the vicinity of Charleston, South Carolina. In Maine still different bacteria may cause a similar yellow decay. Still other bacteria causing a slow, white to brownish decay may be responsible for the destruction of potato seed pieces in Maine fields. These bacteria were isolated from a variety of sources besides potato seed pieces and appear to be the cause of certain soft rots that occur in members of the mustard family and probably in other plants.

Pathogenic bacteria were isolated from the discolored vascular bundles of tubers and from tubers affected with a "stem-end browning disease." These two kinds of bacteria are quite similar to each other.

THE ROLE OF INSECTS IN THE DISSEMINATION OF POTATO BLACKLEG AND SEED-PIECE DECAY[5]

This paper deals with the part taken by certain insects in the dissemination of potato blackleg and seed-piece decay and with the

[5] This is an abstract of a paper by Reiner Bonde having the same title and published in the Journal of Agricultural Research 59:889-917. 1939.

factors which influence the attack by insects and the consequent development of these diseases.

Certain insects are commonly associated with blackleg and seed-piece decay in Maine. Some of these insects are merely scavengers and feed on decayed vegetable matter. Among the insects belonging to this group are the common housefly, *Musca domestica,* the false cranefly, *Trichocera* sp., a fungus gnat, *Sciara tridentata,* and two pomace flies, *Drosophila funebris* and *D. bruschii.* The larder beetle, *Dermestes lardarius,* is commonly associated with decayed potato material, and in a few cases the larvae have been seen penetrating healthy potato tissue. The wireworm larvae, *Cryptohypnus abbreviatus,* often attack healthy potato seed pieces, but this injury does not appear to be responsible for decay. None of the above insects appear to be factors in the dissemination of blackleg and the decay of seed pieces.

A certain Staphylinid insect appeared capable of causing the destruction of potato seed pieces. The larvae of this insect are very active and burrow deeply, extending the decayed areas and thereby hastening the destruction of the seed pieces.

The seed-corn maggot and the seed-potato maggot were found to be commonly associated with decayed seed pieces and the blackleg disease. Blackleg and soft-rot of potato seed pieces were produced by inoculation with these insects under controlled laboratory conditions. The soft-rot organism and other pathogenic bacteria were isolated from inside the adult insect and the puparia, and from the surface of the eggs of the seed-corn maggot. Certain soil bacteria appear to be essential for the development of the larvae to the adult stage. It is of significance that the soft-rot organism was reisolated from the pupae of the seed-corn maggot that had been reared in the laboratory and overwintered in soil in the field exposed to the rigorous climate of northern Maine.

Although the seed-corn maggot and the seed-potato maggot may aid in producing seed-piece decay and blackleg, they do not normally attack potato seed pieces that are healthy and free from decay. They generally enter through lesions that are present in the cut surfaces of the potato seed pieces. In South Carolina these primary lesions commonly occur in abundance when freshly cut seed pieces are planted in moist and warm soil. The seed-corn maggot may be attracted to these lesions and enter in great numbers and by burrowing and introducing pathogenic bacteria cause the de-

struction of the seed pieces. An active decay does not take place in the infected seed pieces unless the moisture content of the soil is relatively high. In South Carolina the formation of seed-piece spotting from soil contamination and the accompanying injury caused by the seed-corn maggot can be prevented by allowing the seed pieces to suberize before they are planted.

In Aroostook County the conditions are somewhat different. In this region both the seed-corn maggot and the seed-potato maggot attack potatoes. They generally enter the seed pieces through lesions that have been formed in the bin prior to being planted and not so often from soil contamination as was found to be true in South Carolina. In Aroostook County, under normal conditions, freshly cut potato seed may be safely planted without danger of injury by maggots. Maggots commonly attack potato seed pieces that have been injured by drying. Such seed often decays when planted and uneven stands are secured.

MILK PRODUCTION AND DISTRIBUTION COSTS, AND PRICES FOR MILK IN MAINE[6]

The average cost of milk production based on current prices in early 1940 was estimated to be about one-fourth cent a quart above that of the two previous years, but approximately the same as the average for the five-year period 1935 to 1939. Variations in both production and distribution costs may exist among individual markets because of real estate values, labor wage rates, and board of health regulations. Production costs also vary with differences in seasonal variation in production, climate and soil conditions, and milk production per cow. Factors considered in determining producers' fluid milk prices were the cost of milk production, the butterfat test of milk, the proportion of surplus milk, prices in competing markets, the general price level, and dairy cow numbers.

The method of computing distribution costs was discussed and

[6] This is an abstract of a brief submitted by George F. Dow at a Milk Control Board Hearing at Bangor, April 2, 1940, sections of which were published in Farm Economic Facts, mimeographed quarterly by the Department of Agricultural Economics and Farm Management, University of Maine, under the heading of Milk Production Costs and Producer Prices, April, 1940, pp. 791-794; and Milk Distribution Costs, June, 1940, pp. 815-820.

a summary of costs was presented. Costs of distribution usually were higher in the larger markets because of higher real estate values, high wage rates for labor, and more detailed milk regulations. Other factors affecting costs were seasonal variation in sales, special services, pasteurization, volume of sales per distributor, and duplication of routes. In considering the establishment of retail milk prices, factors included were production and distribution costs, and also price trends and consumer purchasing power.

Pruning of the Low-Bush Blueberry[7]

The low-bush blueberry is pruned by burning the plants to the ground every two or three years. In the spring of 1930, 48 plots, each one by two rods, were pruned part by an oil burning, part by hay burning, and part by cutting the bushes as close to the ground as possible with hedge shears. The treatments were repeated on part of the plots in 1932 and every even year thereafter. The remainder of the plots were pruned in 1933 and every third year thereafter.

The cost of burning blueberry land with hay varies from $6.78 to $11.75 per acre, while the cost of burning with oil varies from $3.94 to $9.05 per acre.

The results of this experiment indicate the following: two-year burning is not as desirable a practice as three-year burning; cutting cannot be substituted for burning; the yield of blueberries is as great when the plants are burned with oil as when burned with hay; and burning with oil may be cheaper than burning with hay.

The Effect of Growth Substances on the Rooting of Blueberry Cuttings[8]

Three experiments have been conducted to study the effect of growth substances on the rooting of high-bush blueberry cuttings. Indole-3-acetic acid, indole-3-proprionic acid, phenyl acetic acid

[7] This is an abstract of a paper by F. B. Chandler and I. C. Mason having the same title and published in Amer. Soc. Hort. Sci. 37:609-610. 1939.

[8] This is an abstract of a paper by F. B. Chandler and I. C. Mason having the same title and published in Science 92:35. 1940.

and auxilin were used in these studies. Phenyl acetic acid was the only substance which increased the rooting of blueberry cuttings.

CORRODENTIA AS PESTS OF GROUND FEED[9]

A species of insects (*Troctes divinatorious* Müll) of the order Corrodentia, commonly known as book lice, were found infesting stored samples of ground feed. Adults and nymphs were present in great numbers. Samples of feed infested were stored in sealed glass jars and it is probable that these insects infest feed in the several localities of the State from which the samples were received.

INSECT PEST CONTROL IN YOUNG ORCHARDS[10]

A concise discussion of the important insect pests affecting young apple orchards in Maine. Recommendations are given for the practical control of each pest.

TEN YEARS OF WARFARE AGAINST THE BLUEBERRY MAGGOT[11]

The campaign against the blueberry maggot, or fruit fly, in eastern Maine during the 10-year period, 1928-1937, has offered an unusual opportunity for observing the performance of a system of insect pest control in practical use.

After two years of intensive research, recommendations were ready for the summer of 1928. The recommended control consisted of two applications of calcium arsenate, each at the rate of 6 pounds per acre. The first application was to be made 7 to 13 days after the first flies emerge, the second application, 7 to 10 days later. Growers in Washington County began large-scale control operations in 1928, when about 900 acres were dusted. Larger areas were included each succeeding year, until it was estimated that in 1930 approximately 14,000 acres, and in 1937 approximately 18,000

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[9] This is an abstract of a paper by John Hawkins having the same title and published in Jour. Econ. Ent. 32:467. 1939.

[10] This is an abstract of Bulletin No. 274, by F. H. Lathrop, published by the Maine Extension Service, 1940.

[11] This is an abstract of a paper by F. H. Lathrop published in Jour. Econ. Ent. 32:510-513. 1939.

acres, were treated. Since about 1935 there has been an increasing tendency for the growers to make three applications of the dust to their most productive blueberry fields.

Results of the treatments were ascertained from the inspector's reports from a blueberry cannery in Washington County. The reports are based upon a total of approximately 260,000 bushels of berries, to a considerable extent gathered from areas that were heavily infested with fruit flies when the work started. Although there have been fluctuations from year to year, due in part to economic factors, the results have been thoroughly satisfactory. In 1927, the year before dusting started, 53.6 per cent of the blueberries coming to the cannery contained from 13 to 100 fruit fly larvae per 20 ounces of berries. In 1939, after 10 years of dusting, only one-half of one per cent of the berries was so heavily infested. During the same period, the proportions of desirably clean berries (0 to 2 larvae per 20 ounces of berries) increased from 18.5 per cent in 1937 to 90.8 per cent in 1939.

METEOROLOGICAL OBSERVATIONS

The Station is indebted to the Department of Physics of the University for the meteorological summary for Orono for 1939 which appears on the following page.

The instruments used are located on the University campus at Lat. 44° 54′ 2″ N., Long. 68°40′5″ W., Elevation 135 feet. They are the same as those used in preceding years and include: maximum and minimum thermometers, rain gauge, self-recording anemometer, vane, and barometers. The observations at Orono now form an almost unbroken record of seventy-one years.

METEOROLOGICAL SUMMARY FOR 1939
U. of M. Orono, Maine

1939	January	February	March	April	May	June	July	August	September	October	November	December	Average	Total
Highest temperature	46	52	52	68	83	88	97	91	95	78	57	54	—	—
Lowest temperature	–12	–10	–4	20	29	34	47	49	25	20	8	–5	—	—
Mean temperature	19.06	20.07	26.46	39.05	52.90	60.85	68.99	70.67	56.08	46.98	32.76	23.89	43.15	
Mean temperature in 71 years	16.23	19.19	30.08	40.87	51.17	61.44	69.26	66.01	59.94	49.09	37.46	23.02	43.65	
Total precipitation in inches	2.16	2.39	2.61	2.08	2.22	3.79	2.77	1.92	3.56	5.11	.36	5.05	—	34.02
Mean total precipitation in 71 years	3.92	4.02	3.49	2.79	3.24	3.48	3.38	3.31	3.52	3.97	3.46	3.58	—	42.16
Number of days with .01 inch precipitation or more	6	10	6	8	10	10	6	7	9	11	4	11	—	98
Snowfall in inches	10	15.75	20.5	6.5	—	—	—	—	—	—	.5	10	—	63.25
Mean snowfall in 71 years	20.92	20.76	13.67	5.29	—	—	—	—	—	.67	5.88	14.93	—	82.12
Number of clear days	12	11	13	9	11	7	8	6	10	6	15	8	—	116
Number of partly cloudy days	13	7	8	12	13	15	18	18	8	13	8	13	—	146
Number of cloudy days	6	10	10	9	7	8	5	7	12	12	7	10	—	103
Average wind velocity in miles per hour	4.33	5.49	4.75	4.64	3.91	3.75	3.27	2.98	3.90	4.06	4.66	4.60	4.19	

METEOROLOGICAL SUMMARY
U. of M. Orono, Maine
January–June, 1940

1940	January	February	March	April	May	June
Highest temperature	29	56	58	75	92	86
Lowest temperature	–10	–6	–4	20	33	39
Mean temperature	14.91	23.36	28.75	40.27	55.93	61.48
Mean temperature in 72 years	16.11	19.24	30.06	40.87	51.23	61.44
Total precipitation in inches	1.23	2.24	2.35	5.17	2.03	2.12
Mean total precipitation in 72 years	3.88	3.99	3.47	2.82	3.22	3.46
Number of days with .01 inch precipitation or more	3	4	11	11	11	14
Snowfall in inches	.5	13	12	6	—	—
Mean snowfall in 72 years	20.63	20.65	13.64	5.30	—	—
Number of clear days	12	11	7	8	7	3
Number of partly cloudy days	13	11	11	8	12	13
Number of cloudy days	6	7	13	14	12	14
Average wind velocity in miles per hour	4.84	4.31	4.93	4.87	4.44	4.66

METEOROLOGICAL SUMMARY
Aroostook Farm, Presque Isle, Maine
January–June, 1940

1940	January	February	March	April	May	June
Highest temperature	35	37	53	73	83	84
Lowest temperature	–16	–17	–16	6	30	38
Mean temperature	9.6	14.2	22.8	34.9	52.8	59.1
Mean temperature in 14 years	12.6	12.5	23.6	37.3	50.6	60.1
Total precipitation in inches	1.03	1.02	2.83	3.18	2.07	7.51
Mean total precipitation in 14 years	2.11	1.39	2.38	2.51	3.07	3.85
Number of days with .01 inch precipitation or more	6	6	6	10	12	21
Snowfall in inches	8.50	10.50	24.00	.50	—	—
Mean snowfall in 14 years	13.01	9.73	7.23	2.98	.01	—
Number of clear days	11	21	7	8	10	4
Number of partly cloudy days	7	2	5	9	7	10
Number of cloudy days	13	6	19	13	14	16
Average wind velocity in miles per hour	—	—	—	—	—	—

METEOROLOGICAL SUMMARY FOR 1939
Aroostook Farm, Presque Isle, Maine

1939	January	February	March	April	May	June	July	August	September	October	November	December	Average	Total
Highest temperature	41	36	40	51	76	85	91	85	89	67	46	52	—	—
Lowest temperature	−16	−12	−21	18	25	31	45	43	23	18	6	−5	—	—
Mean temperature	10.5	11.1	16.8	34.6	50.0	59.0	67.3	67.0	54.5	43.0	29.2	19.9	38.6	
Mean temperature in 13 years 1927- 1939	12.8	12.4	23.7	37.5	50.5	60.2	65.6	63.7	54.8	43.9	30.3	17.2	39.4	
Total precipitation in inches	1.04	2.30	2.83	4.30	1.92	2.00	6.87	3.08	3.83	5.17	.94	3.33	—	37.61
Mean total precipitation in 13 years	2.20	1.42	2.34	2.46	3.15	3.57	4.31	3.32	3.66	3.67	2.20	2.17	—	34.47
Number of days with .01 inch precipitation or more	5	10	10	11	9	10	12	13	14	11	4	9	—	118
Snowfall in inches	5.50	15.00	15.70	10.00	—	—	—	—	—	3.00	-	4.00	—	53.20
Mean snowfall in 13 years	13.36	9.68	5.94	3.17	.01	—	—	—	—	1.71	3.48	10.79	—	48.14
Number of clear days	15	8	11	13	12	9	8	18	6	10	8	6	—	124
Number of partly cloudy days	1	4	8	5	11	8	9	4	3	4	6	1	—	64
Number of cloudy days*	14	16	12	12	8	12	13	9	21	17	16	24	—	174
Average wind velocity in miles per hour	—	—	—	—	—	—	—	—	—	—	—	—	—	—

* January, June, and July, one day in each month with no data regarding sky conditions.

RAINFALL RECORDS, HIGHMOOR FARM, 1940
May to October, Inclusive
Readings taken daily between 7:00 and 8:00 a.m.
(Inches of precipitation during preceding 24 hours)

Day	May	June	July	August	September	October
	Rain (inches)	Rain (inches)	Rain (inches)	Rain (inches)	Rain (inches)	Rain (inches)
1	—	1.57	.13	—	.21	—
2	.14	Trace	Trace	.01	.01	—
3	.57	.34	—	—	.10	—
4	.21	Trace	.50	—	Trace	—
5	.82	—	.39	—	.01	—
6	.01	—	.14	—	Trace	Trace
7	Trace	—	—	.24	.05	.02
8	—	—	—	Trace	.07	Trace
9	—	.04	—	—	Trace	.17
10	—	.05	—	—	.11	Trace
11	—	.01	—	.06	.85	—
12	—	.08	.40	.01	Trace	—
13	—	.04	.01	—	Trace	—
14	Trace	.14	—	Trace	—	—
15	—	Trace	—	—	Trace	Trace
16	Trace	.21	—	—	—	.09
17	Trace	Trace	—	—	1.06	—
18	.52	—	—	—	.01	Trace
19	Trace	.02	—	.10	Trace	—
20	Trace	Trace	—	1.34	.09	Trace
21	.08	.29	.01	Trace	.05	—
22	.05	Trace	—	—	.59	—
23	.04	Trace	.03	Trace	Trace	—
24	.10	—	.01	.07	—	—
25	.18	.01	Trace	Trace	.11	—
26	.09	.05	.01	Trace	1.34	—
27	.01	.81	.11	—	Trace	.04
28	—	.02	.10	—	—	Trace
29	.18	.20	Trace	Trace	Trace	Trace
30	Trace	.07	.29	—	—	—
31	—		1.30	.15		—

REPORT ON THE FINANCES OF THE STATION

The Station is a department of the University and its accounts are kept in the office of the Treasurer of the University. The books, voucher files, etc., are, however, all distinct from those of the other departments of the University. The classification of accounts is that prescribed by the auditors on the part of the Federal Government, and approved by the State Auditor. All of the accounts may be audited by the State Auditor, and the Hatch Fund, Adams Fund, Purnell Fund, and Bankhead-Jones Fund accounts are also audited by the Office of Experiment Stations acting for the Secretary of Agriculture of the United States in accordance with federal law.

The income of the Station from federal and state appropriations for the year that ended June 30, 1940, was:

U. S. Government, Hatch Fund	$ 15,000.00
U. S. Government, Adams Fund	15,000.00
U. S. Government, Purnell Fund	60,000.00
U. S. Government, Bankhead-Jones Fund	20,692.16
State of Maine, Mill Tax, Other Income, Sales, etc.	49,370.52
State Dept. of Agriculture (Inspection Analyses)	19,815.17
State Dept. of Agriculture (Potato Tax)	18,518.99
Printing	5,940.00
Fellowships and grants	2,050.00
*Potato Tax Receipts	4,861.93
Total income	$211,248.77

The cost of maintaining the laboratories for the inspection analyses is borne by analysis fees and by the State Department of Agriculture. The income from sales at the experimental farms and the poultry plant is used for the expense of investigations.

At Aroostook Farm there are, in connection with the cooperative work with the Federal Department of Agriculture, certain expenditures for the Department made from sales of crops from Department investigations. These expenditures are not included in the tabular statements. They are carried as distinct and separate accounts, always with credit balances on the Station ledger.

*Receipts from sale of potatoes bought with Potato Tax Funds in storage study. Funds used to defray expenses in Potato Tax projects.

REPORT OF THE TREASURER FOR THE YEAR ENDING JUNE 30, 1940
INCOME AND EXPENSE
Federal Funds

	Hatch	Adams	Purnell	Bankhead-Jones	Total
INCOME	$15,000.00	$15,000.00	$60,000.00	$20,692.16	$110,692.16
EXPENDITURES					
Salaries	9,208.34	10,219.92	37,726.96	18,029.17	75,184.39
Clerk hire	1,100.00	249.99	763.21	—	2,113.20
Labor	1,230.52	2,865.73	8,927.88	966.83	13,990.96
Supplies and materials	428.04	786.42	4,523.29	790.70	6,528.45
Communication service	407.28	—	6.15	—	413.43
Travel	464.73	130.34	2,209.23	649.51	3,453.81
Transportation of things	70.75	17.98	88.53	35.44	212.70
Printing and illustrating publications	120.05	—	30.06	—	150.11
Heat, light, water, and power	895.19	241.33	808.33	—	1,944.85
Contingent expenses	28.16	—	—	—	28.16
Equipment	941.11	488.29	4,901.96	220.51	6,551.87
Buildings and land	105.83	—	14.40	—	120.23
TOTAL EXPENDITURES	$15,000.00	$15,000.00	$60,000.00	$20,692.16	$110,692.16

REPORT OF THE TREASURER FOR THE YEAR ENDING JUNE 30, 1940
INCOME AND EXPENSE
State Funds

	Bankhead-Jones Offset	Maintenance	Aroostook Farm	General	Highmoor Farm	Inspection Analysis	Potato Tax	Potato Tax Special Investigation	Printing	Total	Combined Total
INCOME	$20,692.16	$17,528.41	$6,176.92	$2,798.89	$3,424.14	$19,815.17	$15,485.57	$3,033.42	$5,940.00	$94,894.68	$205,586.84
EXPENDITURES											
Salaries	15,162.86	701.66	3.50	—	185.00	12,230.10	1,945.27	—	—	30,228.39	105,412.78
Clerk hire	—	100.00	—	—	—	300.00	—	—	—	400.00	2,513.20
Labor	3,145.51	2,336.35	2,364.03	1,321.10	4,171.51	4,763.05	3,447.27	473.50	—	22,022.32	36,013.28
Supplies and materials	1,129.69	1,309.47	584.06	37.14	2,599.68	1,080.68	5,317.33	222.66	—	12,280.71	18,809.16
Communication service	—	185.91	97.87	—	101.18	146.86	23.68	3.24	—	558.74	972.17
Travel	627.32	1,596.86	32.87	—	1.80	352.27	2,189.01	159.75	—	4,959.88	8,413.69
Transportation of things	39.22	215.90	113.65	.80	12.57	118.37	242.58	99.98	—	843.07	1,055.77
Printing and illustrating publications	46.44	65.08	15.98	—	—	—	15.41	—	5,940.00	6,082.91	6,233.02
Heat, light, water, and power	93.11	468.12	361.82	73.70	1,415.58	586.30	26.03	—	—	3,024.66	4,969.51
Contingent expenses	—	301.37	43.09	—	45.88	10.00	190.78	—	—	591.12	619.28
Equipment	273.00	3,321.06	951.16	43.11	2,013.36	183.59	1,102.84	67.80	—	7,955.92	14,507.79
Buildings and land	175.01	448.27	2,743.97	—	646.60	43.95	985.37	2,006.49	—	7,049.66	7,169.89
TOTAL EXPENDITURES	$20,692.16	$11,050.05	$7,312.00	$1,475.85	$11,193.16	$19,815.17	$15,485.57	$3,033.42	$5,940.00	$95,997.38	$206,689.54